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OF

THE NEW YORK STATE COLLEGE OF FORESTRY
AT SYRACUSE UNIVERSITY



IMPORTANCE OF ANIMALS IN FORESTRY

LAND-ECONOMIC SURVEY IN MICHIGAN

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** Resigned as Station Ichthyologist October 1, 1921.

† Including only those who have made field investigations and whose reports are now in preparation.

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THE RELATION OF FORESTS AND FORESTRY TO HUMAN WELFARE

"Forests are more than trees. They are rather land areas on which are associated various forms of plant and animal life. The forester must deal with all. Wild life is as essentially and legitimately a part of his care as are water, wood and forage. Forest administration should be planned with a view to realizing all possible benefits from the land areas handled. It should take account of their indirect value for recreation and health as well as their value for the production of salable material; and of their value for the production of meat, hides and furs of all kinds as well as for the production of wood and the protection of water supplies.

"Unquestionably the working out of a program of wild life protection which will give due weight to all the interests affected is a delicate task. It is impossible to harmonize the difference between the 'economic, the aesthetic, the sporting and the commercial viewpoint. Nevertheless, the practical difficulties are not so great as they appear on the surface."

HENRY S. GRAVES,
Former Chief Forester, U. S. Forest Service.
Recreation, Vol. 52, p. 236, 1915.

WILD LIFE AND DEMOCRACY

"Above all, the people, as a whole, should keep steadily in mind the fact that the preservation of both game and lesser wild life—by wise general laws, by the prohibition of the commercialism which destroys whole species for the profit of a few individuals, and by the creation of national reserves for wild life—is essentially a democratic movement. It is a movement in the interest of the average citizen, and especially in the interest of the man of small means. Wealthy men can keep private game preserves and private parks in which they can see all kinds of strange and beautiful creatures; but the ordinary men and women, and especially those of small means, can enjoy the loveliness and the wonder of nature, and can revel in the sight of beautiful birds, only on terms that will permit their fellow-citizens the like enjoyment. In other words, the people as a whole through the government, must protect wild life, if the people as a whole are to enjoy it. This applies to game also."

THEODORE ROOSEVELT and EDMUND HELLER.

Life Histories of African Game Animals,

Vol. I, pp. 155-156, 1914.



Drawing by Edmund J. Sawyer.

THE ECONOMIC AND SOCIAL IMPORTANCE OF ANIMALS IN FORESTRY WITH SPECIAL REFERENCE TO WILD LIFE

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INTRODUCTION

The first European forests were set aside because they were the haunts of game. The game was considered more valuable than the timber. At times also, in the early days, the demand by royalty for game was so great that even farms were destroyed to provide forests for game. Thus in wild life forestry, the recreational aspect is historically the oldest phase of forest utilization. (Cf. Marsh, '74, pp. 343-354; Fernow, '11; Waugh, '22.) Later, again and again, the pendulum swung to the other extreme, and lands suitable only for forests were converted into farms, temporarily, only to be abandoned later by their impoverished owners. The virgin forests of America were first looked upon as a hindrance to agriculture and to settlement and were destroyed by every available means. The men who cleared the land were considered public benefactors. The forest wilderness was then a menace to society because in it lurked predatory animals preying upon domestic animals and even attacking man, and it served as cover for Indian warfare. But beneficial as was the clearing of the land, it also went too far, and vast areas were cleared which should have remained in forests. (Cf. Adams, '25, pp. 385-390; '25a; and Leopold, '25.) The economic and social aspects of this phase of our history have been discussed by Marsh ('74), Trotter ('09), and Zon ('20), and their writings well show how present conditions have developed.

That American sportsmen-naturalists were the leaders in setting aside from the Public Domain our first National Parks (the Yellow-

stone) and National Forests (in order to protect the Yellowstone) is not adequately appreciated by the general public or by foresters. For this reason special attention is called to an article by Dr. George Bird Grinnell ('13, pp. 435-491), former President of the Boone and Crockett Club, of New York City, and a Member of the Honorary Advisory Council of the Roosevelt Wild Life Station, in which he points out the role which the members of this Club played in this great movement. The founder of this Club was Theodore Roosevelt and this early movement preceded by many years his later activities in cooperation with Gifford Pinchot. To appreciate the conservation work of these two men reference should be made to Roosevelt's "Autobiography" ('20) and to Pinchot's "The Fight for Conservation" ('10).

Today our greatly increased population, strongly concentrated in cities, and overflowing periodically into the rural districts as auto tourists, vacationists, nature students, campers, hunters or fishermen, wanders over the cultivated fields, and some irresponsible and ignorant persons have already caused sufficient damage to the crops and property to cause the farmers to turn for protection to new trespass laws. But this great urban population can not and should not be bottled up. There should be made provision for an outlet for these people, according to some definite and comprehensive plan. This should not be allowed to remain, as today, a system of guerrilla warfare carried on between the rural and the urban groups. Their interrelations show that the interests of the rural and urban populations cannot be advantageously separated, that they are in fact only different aspects of the same problem, the relation of the people to the land, and to one another. This is primarily a phase of applied human ecology and should be studied as any other ecological problem, in a scientific manner and should be based upon careful surveys and studies, which should result in reasonable policies. This method should lead to comprehensive and sane public policies. This subject is so large, its ramifications so extensive, and its conventional treatment so fragmentary, that confusion thrives. We see that the basal need today is for permanent organizations, both State and Federal, and private, to work out thoroughly comprehensive investigations for this aspect of land utilization. We need, therefore, economic and social surveys of a new type to be made of our natural resources, as phases of the land problem, and in relation to public welfare. Many phases of this subject are already under way by different agencies but there is a lack of the coordination that is essential for a synthetic and compre-

hensive handling of the whole subject. The problem of establishing game preserves, State and Federal, State and National parks, and State and National forests is dependent upon such studies, and on sound ideas on the use of the land. The State of Michigan has made a beginning on such an economic survey (Lovejoy, '23 and '25) and a special paper on this subject by Mr. R. A. Smith, State Geologist of Michigan, has been prepared upon request for this number of the *Bulletin* (pp. 679-692). But ultimately such surveys must include the social aspects, as public welfare generally suffers when these two aspects are divorced, because the ultimate criteria of public welfare are social (Adams, '24, '25). In estimating the relative value of lands, some reasonable system of rating them should be developed, and in this connection attention is called to a particularly suggestive paper on land classification and utilization by Sauer ('22).

The public land policies of the nation have developed rather chaotically and only in relatively recent years has the subject begun to receive serious study. We have seen the disappearance of the frontier, and the disappearance of free agricultural land. This has meant largely the disappearance of free pasture on the Public Domain and of cheap meat, the increasing value of farm land, the higher cost of living, and an alarming decrease of wild life, and therefore, on account of all these conditions, we have found an economic and social stimulus for learning what all this means (cf. Howe, '17; MacKaye, '19; and Magnusson, '19). Dr. O. E. Baker ('23) has recently pointed out that agriculturally we have reached a transitional period, a truly critical stage in our national development. He says (l. c., P. 26): "Our nation is probably near, possibly past, the crest of greatest average income per capita; and every increment in population is likely to increase the complaint of the high cost of living." He also suggests that the increasing population will lead to the "more intensive use of the better land rather than by the extension of crop production [agricultural] onto the poorer lands." He further estimates that by 1950 the United States will have a population of 150 millions, and advocates (p. 26) an economic land survey as one method of making plans for the maintenance of this great population. I would suggest an economic and *social* land survey as a leading essential.

The preceding discussion indicates something of the kind of background which is needed for a discussion of the relation of animals to forestry, because as has been shown, the use of land for forestry and forest wild life is merely a phase of the general problem of land

utilization. Until the broad relations are appreciated, the special aspects of the wild life problem in forestry cannot have a proper setting or perspective. Because the wild life of our country has been considered public property, belonging to the State and to the Nation, and as fish and game organizations were developed in the various states before forestry came to be similarly recognized, these two conservation movements have developed to a large degree independently. There are today only three states which do not have fish or game departments, and there are about 16 states without a definitely organized forestry department. Although in recent years there has been a marked tendency to concentrate all such state departments under a single conservation commission, much remains to be done to perfect such organizations. Thus, because of the accident of independent development, and because some of the forestry leaders have considered wild life as merely a phase of "forest protection," grouping it with fire protection, forest pathology, and other protective problems rather than primarily as a phase of "forest production," or "forest utilization," they failed to see that the cultivation of animal crops was not only a legitimate forest crop, but is one of the greatest aids in establishing general forestry upon a substantial financial and sound administrative basis. (Cf. Adams, '16.)

The object of this paper is to bring together some of the most important evidence and data showing the economic (and social) importance of forest animals, and to call special attention to the wild life aspect of this problem in such a manner as to show its relation to general conservation policies. If forestry is the proper utilization of the non-agricultural land areas for the best human advantage, then all possible uses should be included in the regional control of forest lands and their included waters. It is worthy of special note that the animal crops which can be secured from forest lands will be in addition to the usual calculations of revenue for forests, which are as a rule based solely on the timber crop. The present discussion of forest animals will consider first their importance as producers of human food, then the production of fish and game for both food and recreation, and as producers of fur. Next the financial aspects of the problem are discussed; and finally certain policies and procedure needed to promote a better appreciation and utilization of these animal resources. I have emphasized the economic relations of commercial forests in this paper and have given less attention to forest parks, not because they are not a part of the broad problem of handling forest lands, but because I wish to discuss that aspect rather fully on another occasion. (For a dis-

cussion of certain aspects of this subject see Adams, '24, '25, 25a, b.) The important relation of birds to the control of forest insects is also not discussed here because of its treatment elsewhere in this series of *Bulletins*. (Silloway, '23; McAtee, '26.)

Too much emphasis cannot be placed upon the fact that when dealing with a long time crop, as in the case of timber, it is of the utmost importance to have *annual crops of animals* which will contribute materially to the annual maintenance of the forest and of the community. Forest animals enter largely into most phases of forest recreation, and many phases of general education, aspects of forestry that are now rapidly receiving recognition from the public as of great importance in forestry. This public is already interested in recreation, wild life, in certain aspects of natural history, both from the educational and recreational standpoint, and in fishing and hunting. This public is a large one, involving a large part of the population, it is active, interested and intelligent, is often well organized, and under proper leadership can do a vast amount of good for any sane program for the proper utilization of forest lands. Their organizations today are to be numbered by the hundreds, and their membership by the millions, and they many times outnumber those keenly devoted solely to the timber as an economic crop. Their interest is largely social and their cooperation must be secured before a thoroughly comprehensive use of the lands can be formulated and executed.

PRESENT STATUS OF THE FOREST FOOD PROBLEM

Character of the Food. The present chapter is limited to those human foods derived from forest animals, and it is not concerned with those derived from trees or other plants. We are therefore concerned primarily with the crop of fish, game, wild fowl and grazing animals, which are valued for sport and for food. I am not, of course, advocating generally that wild life be commercialized for food, but we should recognize that it has a potential food value as well as a recreational and educational value which should be considered in any comprehensive forestry plan. As the proper use of forest lands always involves long time calculations, these potential food animals should be adjusted to this general program. Land which is too steep, too stony, too sandy, too sterile, too wet, too dry, or at too great an altitude above the sea, for successful agriculture, may be admirably adapted for some kind of a forest and forest animal crop. Agriculture cannot tolerate such extremes of

topography, soils and waters, as are generally common in forests. This physical diversity naturally reveals itself also in the corresponding difference in the types of forest, and in the variety of wild and domestic animals which can live in such physically complex areas. Thus the hills, mountains, rivers, lakes, ponds, conifer and hardwood forests, all combine to produce a great variety of physical and biological conditions, which favor the production of a corresponding variety of animal crops, such as fish and game, as well as domestic grazing animals. These animals are today grown in considerable numbers, particularly in the open forests of the West, and to an increasing degree in the Eastern forests.

Methods of Producing the Crop. Methods of producing woodland food crops range all the way from those which are wholly wild to carefully supervised herds of domestic animals. The encroachments upon the forest wilderness are rapidly replacing the wholly wild crop by those which have a certain amount of protection and supervision. We should consider fire protection, which is progressively penetrating even the remote forests, as a phase of wild life protection. Wilderness herds do not even get that much help from man. A certain amount of predatory control also belongs in the same category. In some forests there are game preserves and game sanctuaries, occasionally with winter feeding, and finally there may be fairly strict enforcement of intelligent fish and game laws. There is, however, no general plan to protect wild life from diseases and parasites, although incidentally, in connection with the protection of domestic animals, there is a certain amount as happens in the case of rabies, and in the destruction of ticks and other parasites. Even diseased fish are sometimes shipped broadcast from hatcheries, probably without evil intent, probably with the hope of their recovery, but this method disseminates disease widely and should not be permitted. Possibly also poison plant control aids to some degree, although Dr. C. Dwight Marsh informs me that there is little evidence that wild animals suffer from poisonous plants.

The system of predatory control aims to protect domestic animals and game, particularly the herbivorous kinds, from wolves, coyotes, mountain lions and similar predators. Up to a certain point this gives protection, but if carried too far, rabbits and small rodents of various kinds, which are normally preyed upon by the predators, will increase to such a degree that they will destroy the forage needed by the large grazing animals, and a trapping or poisoning system must be inaugurated to check the rodents, and even though certain

species are killed off others are likely to take their place if control measures are not permanent.

The management of domestic animals, grazing in the forest, like the wild life, is likewise subject to many degrees of supervision. Grazing animals may be turned "loose" in the forests or farm woodlots, or they may be carefully supervised, after the various systems which have been worked out by the Forest Service for the Western forests, phases of which are referred to later.

The increase of fish in forest waters is largely managed by the planting of young fish by both the U. S. Bureau of Fisheries and from the various State authorities, and by their distribution for planting by local volunteers or officials. Fish hatching is conducted on a larger scale in America than elsewhere in the world, but the American system is particularly weak in its treatment of the fish after leaving the hatcheries. Great numbers are planted improperly, by careless and inexperienced persons, and in waters unsuitable for them. Chase ('13, pp. 188-189) well states that situation as follows:

"Experts have solved most of the problems connected with the business at the hatcheries; but the field of investigation to obtain the best results in planting game fish in wild waters appears to be still open, and theorists are constantly discussing this feature in publications devoted to the interests of sportsmen.

"Here, then, is where the chief problem now lies, and it should not be left to novices to decide. It is universally recognized as the one important difficulty to overcome, and yet, strange to say, a majority of our leading fish culturists seem to have given the matter little or no attention in the past. They have devoted their entire time to solving hatchery problems and at last these have been reduced to such an exact science that the experienced culturist can now calculate in advance to a nicety his season's output and the total funds required for its development. But has he given any thought to the ultimate fate of his products when they are planted in public waters? We have already called attention to the careless custom of distributing game fish for planting. That point needs emphasizing, and it is to be hoped that experts will take such measures in the future as to prevent this excessive waste in every State in the Union. As we have said, in the past it has been the custom of culturists to assume that their full duty was done when they had raised a large, healthy stock of fish for planting. But when we look for permanent results and benefits from their work, it is certain that their task was only half finished. In the future they must abandon the hatcheries to their trained subordinates and seek the streams,

ponds, and lakes, and there apply their talents. Their first labors have, indeed, been well performed, and it is confidently believed they will now take up these other important problems and solve them with equal success."

The policy of the U. S. Bureau of Fisheries, has been stated by Dr. Hugh M. Smith ('10, p. 1371), formerly Commissioner, as follows:

"The Bureau has labored to make its operations commensurate with the extent of the fisheries in public waters, and with the inevitable exhaustion of the native fish life in the smaller lakes and streams incident to the development of the country and the increase of population. The policy, as enunciated by Doctor Goode, has been to carry out the idea that it is better to expend a small amount of public money in making fish so abundant that they can be caught without restriction and serve as cheap food for the people at large than to expend a much larger sum in preventing the people from catching the few fish that still remain after generations of improvidence." (Cf. Kendall, '24.)

The recognition of the importance of breeding as a policy, is here brought out emphatically. This point has frequently been overlooked. It should be kept constantly in mind in dealing with all other forest animals. Dr. Smith further remarks (l. c.):

"From this standpoint it is perhaps fortunate that up to the present the Bureau has not had to devote its major energies to the formulation and enforcement of fishery legislation, but has been able to work directly for the increase of fish life. Public or government fish culture has in America attained tremendous proportions, and exceeds in extent and importance that of all other countries combined. However, the neglect of some of the States to provide the minimum protection to certain species inhabiting interstate and international waters has not only negated the fish-cultural work of the Bureau and of the States themselves, but has practically inhibited it by preventing the possibility of securing an adequate supply of eggs, thus making desirable and necessary the institution of a new policy placing the interstate and international waters under the jurisdiction of the General Government."

It is thus very evident that Dr. Goode grasped the fundamental importance of breeding wild life, and that Dr. Smith clearly recognized the value of the long period of study and investigation which should precede extensive executive action on fisheries. On the other hand, because the Bureau was so free from administrative responsibilities, there has been no public agency which has felt that its

duty was to formulate broad national conservation policies as applied to fisheries, and which takes a truly broad, sane, critical attitude toward current practices. The lack of this sort of leadership has been an important factor which explains many of the grave errors of practice into which we have drifted, and the lack of a satisfactory attitude toward drainage as shown by the general slight appreciation of how to use wet and submerged lands. It has been left to the farmers and land speculators, with the result that much non-agricultural land has been drained which was more valuable undrained, and thus great damage has been done. There is even today only a slight awakening as to proper use of submerged land. Without question some of it will produce as valuable swamp and aquatic crops as will tillable land. By far the best and most comprehensive treatment which we have of fish culture in inland public waters is that by Kendall ('24; see also '18). A comparison with the Forest Service is of interest. This Service is a much younger branch of Federal service than the U. S. Bureau of Fisheries, but in the relatively short time since it has been established it has made vastly more progress on the formulation of policies and methods of caring for forests than has the Bureau of Fisheries for the waters, even during a much longer period (Adams, '25a, b). Possibly a larger amount of practical work would have been an advantage to this Bureau, as it would probably have been more closely in touch with the public needs of the country. On the other hand the Forest Service has been relatively backward in its research, on account of its preoccupation with administrative problems (cf. Adams, '25b). In the case of the fur-seal problem of Alaska, however, after stumbling, the Bureau of Fisheries has really made creditable progress. The Bureau has set, however, the pace for the world in the conduct of its fish hatcheries, and similar breeding methods should now be extended to all other kinds of valuable wild life. The relative neglect of post-hatchery care of fish could be remedied, in part, if following upon adequate field surveys, it used trained wardens to plant, and as well to protect the fish. The various States should cooperate and give similar supervision of their forest lands and waters. The destruction, by Federal officers, of the enemies of fish has made little progress, as has also been the case in the State commissions. The destruction of game has, however, made more advance indirectly, through the destruction of animals preying upon grazing animals in the National Forests, and by the States permitting hunting and trapping, and to some degree by the use of boun-



Fig. 153. The public waters and food production; equalizing the water temperature before planting fish fry in the Cache National Forest, Utah. A successful method of cooperation between the U. S. Forest Service, the U. S. Bureau of Fisheries, the various States and the local sportsmen. Photograph from the U. S. Forest Service.



Fig. 154. Methods of harvesting the fish crop in public waters; Minnesota State fishing. Pound nets set in Red Lake. Photograph from Carlos Avery.



Fig. 155. Contents of one-pound net, Minnesota State fishing. Photograph from Carlos Avery.



Fig. 156. A frog screen on the south shore of Oneida Lake (the white line in the middle distance). The cheese-cloth screen intercepted the frogs on their way to winter quarters, and along it were dug holes into which they fell and were thus trapped. It is now illegal.

ties; but as a rule, we do not seem to have an adequate knowledge for the proper administration of bounty systems.

At present there is a certain amount of cooperation between the Federal Bureau of Fisheries and some of the State governments, which assists much in stocking forest waters; in other quarters the States have been so backward, and have actually interfered with fish culture to such a degree that the Bureau has ceased work in the State, and new Federal hatcheries have been placed in certain States for the duration of "good behavior" on the part of the State authorities. It is highly desirable that there should be policies of cooperation; a condition which will be much hastened by eliminating this work as much as possible from "politics," and putting it in the hands of men who have the training, ability, and the inclination to work out sound policies for their own regions, and relate them to National needs. Our Federal authorities should likewise come forward with general comprehensive constructive policies, as to what they think should be done for the fishery interests, not only for the United States, but as well for cooperation with Canada, Newfoundland and Mexico, where international waters are concerned. The existing cooperation between the Forest Service and the Bureau of Fisheries is worthy of special comment and commendation (Fig. 153). This is a phase of fish production which has not yet become widely known, and it is one of great promise for the future.

Today the Forest Service rangers are one of the most important bodies of organized fish (and game) protectors which we have in America. The Forest Service requires these men to become informed on the planting and protection of fish, and large numbers of the men are State deputies as well. At present there are millions of acres of our National Forests which are to some degree under this system. The mimeographed but not published, "Game and Fish Handbooks," of Districts 2, 3 and 4, of the Forest Service, will be a revelation to those who are not aware of the dawn of this new era in the propagation of fish and game in our forests. A single quotation from the rules (District 3, p. 11) will make evident at a glance the significance of this work, as follows:

"Under the Act of Congress dated May 23, 1908 . . . game and fish work is one of the regular official duties of a Forest Officer, and his efficiency or inefficiency in the discharge of that duty will hereafter be given due weight in determining his official standing for purposes of promotion, demotion, disciplinary action, or removal. No Forest Officer will be reported as 'satisfactory' in the semi-

annual personnel rating, or as Class A or Class B under Sec. 7 of the Form 418 (Civil Service Efficiency Report) who has been derelict of duty in game and fish work since the date of last report. On the other hand, good work will be duly credited."

By this method foresters and the public are learning that wild animals are truly a part of forestry and of wild life conservation.

Harvesting the Food Crop. At present, in too many parts of the United States the inland fishing industry is in almost a state of war with the State officials. The sporting interests are often well organized and secure legislation favorable to their interests and they are not always fair to the food aspect of the problem. There are strong, well financed commercial interests which are well organized, which do not fully recognize the sporting interests or appreciate conservation methods, but there are very few corresponding organizations of consumers interested in good and cheap food fish. In some regions the sporting interests are by far the most valuable, in others the food interests predominate, and there are all degrees between these extremes. In order to secure the best possible sport fishing, there has been a tendency to make so many restrictions that the food industry does not have a reasonable chance, and there may be an unwillingness even to permit the use of cull or rough fish. General impressions and prejudices are rampant in discussions of these questions, and a fair understanding is very difficult to secure, and is often impossible. When fish abound in waters and the price is good, naturally illegal fishing by "pirates" is strongly stimulated. Some of the more intelligent of these men insist that the laws are not fair, and not being fair, they have no respect for them. They consider the officials as working for pay to catch them, and it becomes solely the conflict of wits, to catch and to escape capture. When fishermen are not able to catch fish, which are not sought after by sportsmen, as in the case of rough and cull fish, they feel the injustice the more keenly, and that they are morally justified in this warfare. If, however, there could be established a fair division of the field, some degree of harmony might be developed, but at present neither party trusts or respects the other. At present also the general public, which should be interested in both sides of the controversy, and whose interests are paramount, has learned to get along without its fair share of food and game fish. Surely this is not a permanent condition. The aim should be to work toward a fair and technical, rather than "political" control of all these interests.

The harvesting of the fish crop in inland waters is left largely to State regulation, and has been managed largely in harmony with the predominant local interest, either commercial or sporting. Recently under the economic pressure of the War, Ontario and Minnesota took the lead in State fishing, and have shown that under this kind of supervision the harvesting and sale of certain aspects of the fish crop can, in an emergency, be done very successfully in the interest of the general public, as it had never been done before. This was accomplished in the face of considerable opposition, but the results have been very satisfactory, and have been popular with the public. These experiences have shown that not only the hatching and planting of the fish by the State may be successful, but as well the harvesting and marketing of a part of the crop. The experience of Ontario has been well summarized for me by Mr. S. L. Squire, former Manager of the Sales Branch of the Department of Game and Fisheries, Toronto, whose letter to me of October 9, 1918, states:

"The Government deemed the usual trade conditions, the necessity of conserving beef and bacon for export, and the high cost of living, as sufficient reasons to embark on a policy which to many would seem drastic indeed. In order that conservation of exportable foods might be made possible to a larger extent, the Government of the Province undertook to provide fresh water fish as a substitute for meat. In so doing they contracted with a number of fishermen to operate in some virgin waters, and other restricted areas, this with the desire of increasing production. I might mention that Lake Nipigon, an inland lake having a water area of 1,700 square miles, had not been fished commercially, and that many other inland lakes had been fished sparingly. The entire catch from these lakes was contracted for by this Department, and distribution of same to the public arranged for through the Sales Branch.

"After the first month's operation of the policy it was discovered that the demand for fresh water fish was greatly beyond the expectations of the Government, and it became necessary that further supplies be obtained. To this end, the Department of Game and Fisheries was asked to insert a clause in all fishing licenses which was issued for the year 1918, by which the fishermen who were operating in the international waters were required to furnish to the Government an amount of their catch not to exceed 20% of the total, at prices fixed by the Government. The prices which the Government undertook to pay the fishermen were based upon the average prices which had prevailed during the previous five

years, the Government afterwards allowing 12½% advance on these prices.

"The matter of distribution was the next serious question, many of the more important Municipalities throughout the Province being without a fish store, or dealers who were in a position to handle the product. In order that the Province might be generally served, the Government solicited the co-operation of the Municipal Councils, asking the Municipal Councils throughout the Province to name distributors. That only reliable men might be made distributors of Government fish, the Government required that the Municipalities guarantee the accounts of the dealers so named. The request of the Government has generally met with a hearty response, and today over six hundred dealers in the Province have distributed Government fish. The amount of fish distributed by the Department since May 1st has been greater than the entire amount of fresh water fish sold in the Province by all sources for the same number of months prior to 1914.

"In this brief report you will see that the co-operation of the essentials in the distribution of fish have been regarded by the Government—the fishermen, the transportation companies and the retailers. Wherever possible the Government has had the fish sent directly from the source of production to the distributor. Middlemen have been eliminated, costs have been kept at a minimum, and the people have received the benefit. Government whitefish, trout, and pickerel, have been sold throughout the Province of Ontario to the consumer at 15c per pound on a cash and carry basis." For the details of this experiment reference should be made to the Annual Reports of the Game and Fisheries Department. This work was discontinued in 1922 (16th Ann. Report, p. 7, 1923). In 1919 this system of sales produced a net balance of over \$403,500.

The experience of Minnesota, under the very able leadership of Mr. Carlos Avery, formerly State Game and Fish Commissioner, has also been very successful, (phases of this work are illustrated in Figs. 154, 155), but unfortunately this work has not been widely known. The following is an abstract of Mr. Avery's paper "Minnesota's Experiment in State Fishing" ('18):

"The State War Board, in Minnesota known as the Public Safety Commission, which was appealed to, gave the Game and Fish Department an opportunity to make recommendations. The plan which is now in operation was recommended by the Game and Fish Commissioner as a substitute for the wide-open plan generally proposed.

The Safety Commission approved by formal order, named the Game and Fish Commissioner as their agent to carry on the work according to his discretion, and appropriated \$1,000.00 as his capital stock on which to commence business. With this small beginning the enterprise started and has been self-supporting from the outset, all equipment having been purchased from the fund accumulated from the small margins on fish sales. The value of equipment and other assets at the end of the first year will approximate \$25,000.00."

"Red Lake, the largest lake in the State, is a comparatively shallow body of water some 440 square miles in area. It is nearly all included in the Red Lake Indian Reservation, abounds in certain varieties of fish and has never been fished for market. By agreement with the Department of Indian Affairs, whereby the Indians of the reservation are to receive certain benefits, arrangements were made to open up state fisheries in these waters.

"The intention was, when the State fishing was first inaugurated, to confine it exclusively to Red Lake. It soon became apparent that this would result in a heavy loss for several months and it was realized that in the great numbers of lakes of the state there were certain varieties of fish which were used but little, if at all, and there was no practical method recognized by law to take them in quantities.

"So we began to take tullibees with gill nets, bull heads with hoop nets and pickerel with gill nets and spears, where they were abundant and a considerable portion could be spared for this purpose.

"In this way the demand for fish was met and the enterprise was made self-sustaining while the preparation was going on for more extensive operations in Red Lake. It was not until late in May that pound nets were finally set in Red Lake, since when other state fishing has been gradually suspended as unnecessary. The fish were found to be so abundant that during May and June from two to four thousand pounds at a lift were taken from the pound nets in use.

"No fishing has been done anywhere that would interfere or conflict with regularly licensed commercial fishing or tend to deplete any waters of any species, or to interfere with or injure angling. It has been the policy to take only such species as are of value chiefly as food fish and of little value as game fish. . . ."

"One of the most despised fish with us is the burbot or 'eelpout,' but we have succeeded in inducing the people to eat over 7,000 pounds of them. Our men sometimes camouflaged them 'northern catfish' which seemed to help some."

“ . . . The total production of fish by varieties for the period named has been as follows,—sixteen varieties:

	lbs.
Pike Perch.....	302,333
Mullets	185,242
Pickereel	181,757
Bullheads	104,089
Sheepshead	58,875
Whitefish	58,855
Goldeyes	51,504
Tullibees	48,371
Carp	45,256
Perch	10,295
Burbot	7,678
Buffalofish	2,866
Rock Bass.....	2,015
Sturgeon	390
Catfish	74
Dogfish	28
Total	1,059,628

“At first it was necessary to sell the fish in public markets, on the streets, in department stores, or anywhere to advertise the enterprise and acquaint the people with their opportunity to get cheap fish. Almost invariably the demand greatly exceeded the supply, as the people came in large numbers and bought eagerly of the state fish.

“There has in some cases been a reluctance on the part of regular retail dealers to handle the state fish on account of the margin of profit and selling prices being fixed. We have sometimes found it necessary to sell the fish on depot platforms, in barber shops, general stores, private houses, and on the streets, until a demand was created and the regular dealer recognized the desirability of handling the state fish. . . .”

“ . . . Our plan is to ship by prepaid express to all points in the state. A large part of the distribution in Southern Minnesota is satisfactorily accomplished by shipping from Red Lake to St. Paul in refrigerator carload lots and distributing from there. This insures delivery of the fish fresh and wholesome in midsummer.”

“ . . . For some unaccountable reason there are scores of small towns in our state that never saw a fish on sale until they began to receive the state fish.

"Prior to the inauguration of the state fishing such common and lowly kinds of fish as lake carp, sheepshead, mullets, and goldeyes (mooneyes) were seldom if ever, seen in the better meat and fish markets of the cities and were wholly unknown in the smaller communities remote from lakes where they are produced. By furnishing the fish in a fresh and wholesome condition and at low prices (retailing everywhere at not to exceed 7 cents a pound) and doing some advertising, we have built up a steady demand for the cheaper fishes in many places."

"It has been the intention to keep the prices as low as possible and pay for equipment needed and running expenses. It has been aimed also to maintain prices as nearly uniform as might be the year around. For instance the state has sold walleyed pike uniformly at 12c wholesale (retail 14c) while the same variety produced through regular channels has retailed at from 18c to 24c in the same markets. State whitefish have been retailed at 14c and 16c; other whitefish 22c to 30c, no better in quality. State pickerel have sold at 10c to 12c, other pickerel up to 18c. The state bullheads retail at 14c dressed, others up to 18c. The state rough fish at 7c have been the only fish of the kinds in the markets.

"By careful selection of localities for fishing and discrimination in choice of varieties taken, this great quantity of fish has been taken with little or no injury of any kind. In some cases those varieties which are used but little if at all by local people and consequently exist in abundance have been taken. In other instances a limited number of the better varieties have been taken where abundance will permit. Some remote and little frequented lakes have been made to furnish a portion. . . ."

"It would seem that it were safer and less apt to result in depletion to carry on some of our commercial fishing by this method rather than by licensing commercial fishermen. More discrimination as to waters fished, varieties taken and in methods of fishing is possible and the quantity taken at any time and place is absolutely under control. Unrestrained legal commercial fishing has all but exterminated our Lake Superior whitefish and Lake of the Woods sturgeon, and is rapidly coming to the same unfortunate result with the Lake Superior herring. There should be more state or government control of fishing with a view to conservation and our Minnesota State fishing may furnish suggestions as to more discretion and latitude in control of the industry.

"The benefit to the people of the state and to the country has been unquestioned and apparent. Not only has a large quantity of fish

at moderate prices been made constantly available, but they have been made use of, thus releasing a corresponding amount of meats and other foods for shipment and export. . . ."

Minnesota is also a leader in its methods of harvesting the crop of "rough" fish, such as carp, dogfish, garfish, buffalo fish and suckers, and has thus given another outlet for the fishing industry. The State received two per cent of the gross receipts of the sale of the fish. The licensees give bond and all fishing is done under the supervision of game wardens. During the season of 1915-'16 the fish caught and sold amounted to 3,785,360 pounds, about 200 car loads, which sold for \$168,249.35 and the State received the sum of \$33,649.27 (Klancke, '16, p. 6). Lake Shetek, which had been fished extensively for several years, has an area of about 2,600 acres and is about 15 feet deep. This lake produced 1,047,306 pounds of fish which sold for \$46,656.67. The author states that: "Most of the fish taken found a market in the eastern cities, New York easily getting two-thirds of the output."*

This method of fishing not only secures a supply of fish for food but also gives a practical remedy for controlling an excessive number of rough fish, and keeping them within reasonable limits (cf. Avery, '17), as well as getting rid of overmature fish. Wisconsin (Nevin, '16, p. 24) also encourages the capture of rough fish by means of a contract system, which pays to the State one and one-half cents per pound for all fish sold, as well as the expense of the supervising State wardens. Fish Commissioner Nevin states (l.c., p. 24) that:

"Very few game fish were taken in the nets. Our game fish do not remain in the vicinity of a large school of carp or buffalo. When a particularly large haul of carp was made, 40,000 to 60,000 pounds, not over 75 to 100 pounds of the better varieties of fish would be found in the haul. . . . The season for rough fishing is from September 20 to March 20, at a time when the game fish are not spawning, are in deep water, and for this reason there is practically no damage to the game fish."

In a number of States inland fishing on a commercial scale, especially for rough fish, has been carried on for many years, but the preceding experience above mentioned covers the more unusual and successful methods.

* In passing it is worthy of note that these fish should have been sold inland, and not at the seashore beside salt water fish. They were, further, shipped at a time when the railroads were overloaded. In New York State these "rough" fish abounded, but were not used.—C. C. A.

During the food shortage of the spring of 1917, the New York State College of Forestry presented to Governor C. S. Whitman's Patriotic Agricultural Commission (May 3, 1917) certain suggestions for an increased production of food from forest lands and waters in New York State. It advocated the netting of inland waters for mature food and "cull" fish by State officials during the period of the war, in order to increase the local food supply. At the same time it was equally urged that the output of the hatcheries and "fish nurseries" should also be increased. By placing the fishing in the hands of State officials it was assumed that every reasonable care would be given to see that the fishing was done intelligently, and when further supplemented by an increased hatchery production, the fisheries would not become depleted. There was severe opposition to this on the part of the State Conservation Commissioner (cf. Pratt, Geo. D., *Bull. American Game Protective Assoc.*, Vol. 6, No. 3, pp. 6-7; July, 1917), and only slight use was made of these fish; but as has been shown, Minnesota and Ontario proved conclusively the soundness of this policy, which New York State ignored.

When the Forest Service began the supervision of grazing on the Western National Forests there was violent opposition to this on the part of the sheep and cattle owners, because they feared it would injure their business. The sheep and cattle men had been at war among themselves for many years, but within a few years they learned that they were getting better satisfaction under Government management from the Forest Service, and were doing much better business, than when they had full control on the old basis. Later these same men made an effort to have open non-forest grazing land included within the National Forests so that they could get the advantage of the stabilized conditions given by Government supervision. This is a good precedent and suggests that similar greater Federal supervision of fish, game and other wild life of the National Forests would be a great advance. The necessity of harvesting the animal crop has been expressed by Graves ('15, p. 2) who states:

"There must be some means of taking care of the natural increase of game after a certain point is reached. Hence any policy of wild life protection as applied to game animals must sooner or later be accompanied by hunting as a practical necessity. Otherwise protection will sooner or later break down of its own weight."

A recent constructive proposal along this line has been made by Leopold ('18) who suggests a method of harvesting the game in

National Forests by the issuance of Federal game licenses or hunting permits. Such a plan would make the game, when ready to harvest, available by a system similar to that of timber and forage. Such a plan should be extended to all wild life, including the fish, and at once a comprehensive plan would be had for the harvesting of the wild life crop in National Forests, which would coordinate State and Federal supervision.

Our treaty with Canada in regard to migratory birds is a very important one, because it gives definite recognition of Federal wild life supervision. In the enabling act it states that: "Sec. 12. Nothing in this Act shall be construed to prevent the breeding of migratory game birds on farms and preserves and the sale of birds so bred under proper regulations for the purpose of increasing the food supply."

The harvesting of the crop of grazing food animals in the National Forests is managed as a private business, as in the case of other domestic animals. The care of these animals is much the same as that for other domestic grazing animals, except that they are subjected to a forestry management intended to protect the forest so that it may produce a sustained yield of both forage and timber. They also receive protection from predatory animals (see Figs. 174-179) by Federal official hunters and there is also some supervision of Federal and State officials over contagious diseases, and finally they are inspected for parasites at the packing houses. Today the Forest Service is in charge of the largest area of supervised forest grazing land in America, and on the basis of its extensive experience it has made much progress in the practical handling of grazing animals in forests. (Cf. Barnes, '26.)

In the preceding discussion of grazing animals in National Forests horses have not been considered as food animals. These Forests are now grazing large numbers of them, a food resource but slightly used in America, but one which may become of value in the future. Of course, great numbers of sheep are grown for their fleece, rather than as food, but they are potential food animals.

The Crop and the Consumer. From the standpoint of the public the production and harvesting of the crops are of no greater importance than their use by the consumer. This is a point which is frequently overlooked. It is playing Hamlet with Hamlet left out. The more or less confused conditions seen in the production and harvesting of the crop of wild life is equally marked in its distribution and use by the consumer. Fish readily deteriorate and generally speaking should be sold promptly. Fish are caught in great quanti-



Fig. 157. A close-up view of the frog screen near South Bay on Oneida Lake, New York.



Fig. 158. Breeding ducks on a small pond at the State Game Farm, Dexter, New York. Ducks are bred with relative ease by this method.



Fig. 159. Ruffed grouse, the most popular game bird in the Eastern woodlands. Photograph by Edmund J. Sawyer.



Fig. 160. Black bear, a female killed in the Lukachukai mountains, Arizona. Photograph by Charles Miller.

ties and the small fishermen must sell quickly, and often at a low price, and must compete with the large firms, who with modern cold storage facilities, can wait. The fisherman generally sells at a low figure and the public buys at a high one. As has been said:

"Yet the sale of fish is almost completely in the hands of combinations or trusts, which control the price paid the fishermen and the price as well as the quality of fish that the local dealer can buy. As a result, fish for which the fisherman receives 3 cents a pound at the wharves is sold a few blocks away at from 15 to 20 cents. Yet the city could easily end this monopoly by the opening of fish wharves to which the fishermen could bring their catch daily and sell at retail or at auction, as is done all over Europe where fish is the universal food of the poor." (Howe, '17, p. 169.)

Minnesota has shown, in part, how to put cheap fish food in the hands of the public. An unusual business man, Mr. George W. Perkins, made a careful investigation of this subject, and claimed that there was an immense waste in the handling of fish on account of defective business methods, such as inadequate storage facilities, and there is of course, wasteful competition. These conditions show that even today production is beyond the capacity of business, as now organized, to distribute properly, and it teaches the very important lesson that there should be improvement all along the line; it is not simply a question of growing two or more fish where one once grew, that will solve the problems here concerned.

With regard to game we have no game business comparable in magnitude to the food fish business, even if we leave out of consideration the marine fisheries. There has been a great mass of restrictive legislation which has been intended, in good faith, to conserve the game, and doubtless it has done much good, but it has led many astray. This has led the average sportsmen to think that restrictions on the killing is a more productive method than direct propagation, while both methods are essential. The cattle, hog and sheep business thrive, and very little is heard about the restriction on killing, because the breeder knows how to maintain the proper balance between breeding and killing. Legislation is probably cheaper than breeding, but it is not so productive! It seems probable, that in addition to propagation and reasonable harvesting, that a combination of preserves, sanctuaries, and other breeding establishments, point in the direction of the greatest hope for increasing wild life. Furthermore the encouragement and breeding of wild life on preserves, and its sale for food, will probably, under proper supervision, do something to conserve the breeding stock of other wild life, but

will not contribute much to the problem as a whole. Game breeding on private lands may possibly take its place beside the private fishing business, as an established industry, but at present this seems far in the future, if we compare it with European conditions (Westerfeld, '16), and from the standpoint of our democratic traditions it seems very undesirable.

It is quite evident that the various problems here sketched are complex and involve the interests of everyone. With these considerations in mind let us turn to certain technical details which underlie production and utilization of forest animals, bearing in mind all the while the fundamental relation of production to consumption.

FOOD PRODUCING CAPACITY OF FOREST REGIONS

General Remarks. The human food producing capacity of forest lands and waters from animals varies greatly with local conditions, and with their management. While census and crop reports give much attention to production of tilled lands there is very slight attention given to wild life, and usually the published data is of very unequal, and often of slight value. Although estimates of growth increment of timber have long been used in forestry, and grazing management has been developed to a considerable degree on a quantitative basis, wild life has been neglected, and only a beginning has been made in this phase. Before we can make precise estimates of production it will be necessary to devise censuses, and methods, of determining the rates of animal increase. At present most wild life activities are conducted without adequate knowledge of either of these items, and it has only been in very recent years that efforts have been made to make even approximate game censuses. A convenient source of information on the human food producing capacity of agricultural lands has been prepared by Cooper and Spillman ('17) which is very valuable for comparison with wild lands.

We have, however, a certain amount of general information about the productiveness of forest crops based largely on estimates of abundance and the annual kill, which serve as a general guide for our expectations. These estimates are of course provisional in character, and this should be clearly understood, and the urgency of securing better ones is strongly emphasized. Careful surveys and experiments are the only means which will improve this condition. Attention is called to the fact that the fish statistics are mainly those of the commercial fisheries, as we have no accurate method of learn-

ing the amount of fish taken by private fishermen and sportsmen, which in the aggregate must be very large indeed. The data on game should also, in general, be considered as only rough estimates, and without question are also of very unequal value. In nearly all this work there has been a conspicuous absence of a critical study of the technique used in making such estimates.

We need careful estimates of the basal food producing capacity of the land and water for all animals, whether it is forage or browse for the herbivorous, or other animals for the predators. Only relatively few studies of this basal animal food supply have been made, aside from grazing, and strangely most of these have been made for aquatic animals. Many years ago a number of quantitative studies of the microscopic life in our fresh waters were made by Forbes, Reighard, Kofoed and others, in their efforts to determine its importance as food for fish. In recent years Baker ('18) made an intensive study of the macroscopic invertebrate fish food in Oneida Lake, New York, to determine the relative fish food productivity on various kinds of lake bottom, and later extended such studies to the Lake Winnebago region of Wisconsin ('24). Muttkowski ('18) has made a somewhat similar study of Lake Mendota, Wisconsin, and recently Adamstone and Harkness ('23), and Adamstone ('23 and '24) have made a study of the fish food of the bottom of Lake Nipigon, Canada. The only important study of the fish food productivity of a river bottom is that of the Illinois, made by Richardson ('21), after the plan of Baker's studies in Oneida Lake. Similar studies as has been said are needed for all phases of the animal problems of forests.

Fish Productiveness. *Small Streams.* Small streams are relatively abundant in forests because humid uplands are generally forested. Yet in spite of the fact that such streams are so widespread and abundant, they have received little study, and we know very little of their relative productivity. After diligent search I am unable to learn how much trout can be reasonably expected from a given mile of trout stream for any given period of time. Dr. W. C. Kendall has made some census studies of the streams in the Allegany State Park in New York for the Roosevelt Wild Life Station, the results of which are nearly ready for publication, and White ('24, pp. 137-149) has made a census of trout fry surviving planting in an Ontario stream. It is truly surprising that we have no careful study published on this problem of productivity considering the great public interest in trout.

Rivers. Salmon streams, although they are included in forests, especially on our West Coast, are not, at this time, discussed. The fact should not, however, be overlooked that they are yet within the field because the crop is frequently harvested within the forest area. Our attention, however, will be confined to inland fisheries. The main stream whose fisheries have been studied is the Illinois River. The broad bottoms along this river are so valuable for agriculture that an extensive levee system has been built up along its course to protect the fields from overflow, resulting in economic pressure strong enough to require an intensive survey of the waters in order to determine which interest predominates, fish culture or agriculture; and furthermore what method of river management should be adopted (Alvord and Burdick, '15). The report of this survey, made with the cooperation of Dr. S. A. Forbes, is the most valuable study of the kind which we have of American river conditions. This fishery (l. c., p. 13) is the most valuable inland river fishery in the United States, and is exceeded only by the inland fisheries of the Great Lakes, and the salmon industry of the West Coast.

In addition to the fisheries, the sportsmen are estimated to spend an equal amount for fish and game along the river. The character of this stream should be borne in mind. The extensive bottoms, abounding in swamps and lakes, and the permanent supply of water from Lake Michigan, carrying the sewage of Chicago, combine to make the stream quite unusual. The relatively large production found here is strong evidence that with intelligent management, much may be expected from such a stream. In this connection attention should be called to Antipa's ('12) elaborate investigations of the flooded Danube delta region, and of his plans for increasing its fisheries. It is to be expected that some day the lower leveed portion of the Mississippi, and possibly even its delta, will require similar investigation and management. The St. Clair River, and its delta, in Lake St. Clair, is another allied problem worthy of serious detailed investigation. Fortunately, in both of these cases we already have physiographic surveys upon which to base such work. In New York State the Hudson River should receive similar study in order that these waters be used to the best advantage for fish production.

The most complete data with regard to the amount of fish produced per acre, per mile of river with contributing ponds and lakes, are those published by Alvord and Burdick ('15, p. 61) for the Illinois River. Their estimates are based upon the U. S. Census for 1908. These authors state:

"It will be well to keep in mind that 1908 was a banner fishing year, the total product being more than twice the average of the ten or fifteen preceding years." The estimated yield of fish for 1908 was 23,896,000 pounds. To adjust this to the average production of the five preceding years (as suggested by Dr. S. A. Forbes) would give 12,846,667 pounds for the river. The Illinois Fish Commission's estimate of fish for 1908 is less than that given by the U. S. Census for the same year (Alvord and Burdick, '15, p. 65). They give a yield of 19,270,000 pounds, which for 77,086 acres (from Forbes), or 120.5 square miles of water, equals 250 pounds of fish per acre. If this estimate is also adjusted to one-third less, for the unusual year, it gives 10,880 pounds per square mile of river or 170 pounds per acre. This relatively high degree of productiveness in fish can be expected only under very favorable conditions; a slow stream, with abundant waters, contributing good feeding and breeding conditions, such as abound along the Illinois River, and where the waters have been enriched by sewage.

Lakes and Ponds. In estimating the productivity of lakes the Great Lakes furnish us with the largest area of inland fresh water which contain valuable food fish. The statistics of fisheries for these lakes are of especial value, although of course they do not give a complete measure of the productiveness of these waters. A few other animals than fish are included, but they do not influence the general result to an important degree. These data show that the average total fishery production for the Great Lakes for the years 1880, '85, '93, '99 and 1903 (Smith, '94, p. 363) was 96,504,055 pounds, which on the basis of 91,000 square miles of water in these lakes gives 1,060.5 pounds per square mile, or 1.7 pounds per acre. This is a very small amount of fishery product per acre compared with that of the Illinois River. Such large lakes, with a relatively small amount of soluble food materials accumulating in the shallow waters near shore, are relatively poor in the production of fish compared with the shallower streams and other waters, and particularly when compared with a stream fertilized by sewage, as the Illinois River.

It is seldom that fishery statistics are expressed in pounds per square mile of water. This has been done however by Mr. Paul Reighard in his study of the whitefish of the Great Lakes. He shows ('10, p. 679) that in all the area where the whitefish thrive in the Great Lakes, an area of 25,700 square miles, and for the years 1899 and 1903 respectively, there were 280 and 217 pounds

taken per square mile, or an average of 248 pounds for the two years. Lake Michigan for the same period averaged 592 pounds, and Lake Erie 378 pounds. Patton ('12, p. 21) states that during the five-year interval from 1906-1910 the whitefish area of Canadian Lake Erie averaged 594 pounds per square mile, or .9 of a pound per acre.

Intensive fish culture in ponds, with artificial feeding, like intensive land culture, will however, produce a large crop of fish. Dyche ('14, pp. 67-75, 181-186) reports that he had a pond of about one acre stocked with fish, weighing (it was estimated) about 700 pounds, and not all the fish were planted at the same time. Three years after the original planting it was estimated that about 6,000 pounds, in excess of the weight of those planted, were removed. As a rough estimate this would give about one ton per year, from an acre of water, by artificial feeding.

Intensive fish culture has long been practiced in various European countries, and a summary from Alvord and Burdick ('15, p. 82) has been adapted to our purpose, in the following table No. 1:

TABLE NO. 1—SHOWING SUMMARIZED DATA ON FISH POND YIELDS IN FOREIGN COUNTRIES

	Pounds per acre
1. A German pond fishery with 202 acres in ponds—artificial feeding. Carefully operated. — <i>Fischerei Zeitung</i> , 1907.	
Product almost entirely carp.....	252.
2. E. Walters' estimate of the yield of carp per year in Germany without feeding or manuring from ponds laid dry over winter. — <i>Fischerei Zeitung</i> , 1907.	
On poor uncultivated land, bog or otherwise sterile bottom.....	43.5
On sour and bad meadow land, alder swamps and mud holes.....	87.
On good meadow land.....	174.
On first class ground.....	348.
3. A recorded yield from wild waters, Germany. A pond or lake, 8.83 acres, with hard sandy bottom, depth 9 feet, containing a varied assortment of wild fish. — <i>Fischerei Zeitung</i> , 1908.....	1,517.
4. Unusual yield of carp in small pond culture, Japan, heavily fed. 225 acres, in very small ponds. — <i>Fischerei Zeitung</i> , 1907.....	1,778.
5. Statement as to German yields. — <i>Zeitschrift Fur Fischerei</i> , 1897. If ponds are fed from wastes of farm or of an entire community — pounds of carp.....	267 to 334.

An inspection of this table shows that 1,500 pounds of fish per acre from wild waters is exceptionally large. Attention should be called to the fact that the time involved is not given.

The production of fish by the German pond method, as shown by Alvord and Burdick ('15, p. 83), indicates that 52 ponds having a total area of 202 acres produced 50,919 pounds of fish, or 252 pounds per acre.

Recently the United States Bureau of Fisheries has published (U. S. Fish. Serv. Bull., No. 94, p. 3, 1923) a brief statement of the results of fish production in a pond at the Fairport Biological Station. This states:

“ . . . With this end in view the pond has been handled just as one would be managed in practice; that is, the fish have not been fed but have depended on the natural ‘fish food,’ the small animals and plants that normally form the diet of food fishes and that are naturally produced in the pond.

“The production of the pond has been obtained by computing the difference between the weight of the fish at the time of their introduction into the pond in spring and the weight of the same fish and their offspring as occasionally caught out during the summer or when removed from the pond at the autumn inventory. This method of computation gives the increased weight of fish in the pond due to the ‘turnover’ of small plants and animals. The fish used, the bluegill, feeds primarily on insect larvae, cladocerans, copepods, and plants. This annual net ‘turnover’ of food organisms of the pond into fish flesh is here tabulated. The table includes also the weight of the fish of edible size taken from the pond.

YEAR	Net production per acre		Production of edible fish per acre	
1919.....	203 lbs.	14 oz.	94 lbs.	1 oz.
1920.....	333 "	8 "	54 "	0 "
1921.....	374 "	11 "	92 "	10 "
1922.....	440 "	14 "	101 "	11 "

“The annual production of fish of edible size in 1919 and 1920 was based on the weight of fish removed from the pond by hook and line during the summer. In 1921 and 1922 line fishing was not carried on in the pond and the data on the production of edible sized fish were collected when the fall inventory was made. The use of the fall measurements for this computation necessarily tends to hold down the total possible ‘turnover’ and the total possible production of fish of edible size. The computation, however, as made for 1921 and 1922, can not be far from accurate, though the total net ‘turnover’ and the production of food fish would probably have been somewhat greater had the larger fish been removed at intervals during the summers of those years.

“The effort in manipulating the stock of this pond has been to so control the number of fish of different ages in it that an association might result that would give continual maximum production of fish of edible size year after year. The tendency of the manipulation for the last three years has been to decrease the number of fish constituting the spring plant, so that the small fish produced by them

during the current year might not make up an undue proportion of the total annual production of fish flesh. It has been observed that too great a production of young fish in a given year prevents many of the half grown fish from attaining edible size through too serious competition for the available food."

The results of this table show that an annual production of about 100 pounds of fish per acre can be reasonably expected from small ponds. For a fuller account of this important study reference should be made to a paper by Barney and Canfield ('22).

Johnstone ('08, p. 184) has summarized the productiveness of the German carp fisheries at from 58 to 141 pounds per acre. His comparative statements with regard to the sea are of interest (l. c., p. 180). He states that in the North Sea, based upon the fishery catch as a minimum value, there are 15 pounds of fish per acre yearly. From Morecombe Bay, on the west coast of England, 79 pounds of fish per acre were taken annually. Brandt ('01, pp. 498-499) quotes Hensen on the annual yield of the Bay of Hela, Gulf of Danzig, at 28.2 pounds per acre, and he himself calculates that the "Haff" of Stettin produced 90 pounds of fish per acre per year, and he later adds: "In the case of the 'Hafen' of Stettin, careful verification showed me that the actual catch was between two and one-half and three times as great as the statistics showed." (Cf. Ritter, '18, for a discussion of the utilization of the wild life of the sea.)

Amphibian and Reptilian Productiveness. *Salamanders as Food.* That amphibians and reptiles are a source of food will be a surprise to many until they recall that frogs' legs and turtle soup come from this source. Of course they do not factor large in production but the value is real and can probably be considerably increased when properly investigated. As a human food salamanders have received very little attention, but we have a few large aquatic species which are worthy of consideration. Many years ago Wilder ('74) called attention to the edible qualities of the common mud-puppy, *Necturus*. These abound in certain lakes and streams. In New York State it abounds in Oneida and Cayuga Lakes. In Oneida it is taken in large numbers by the "tipups" of ice fishermen. Pearse ('21, p. 7) remarks:

"After reading what Wilder (1874) says about the delicious flavor of the mud-puppy, the writer fried some and at once became an enthusiastic devotee of the dish. The meat is fine in quality and very white. It rivals frog legs in flavor and is more desirable because it comes in larger 'packages,' the body muscles of an adult mud-puppy being more bulky than the legs of the largest frogs.

"To prepare this animal for the table it should be decapitated, skinned, and eviscerated. The legs are too small to furnish much meat, but the muscular body contains considerable and is free from bones. The animal should be dipped in flour or corn meal and fried until thoroughly cooked. The meat is tough if not well done.

"The mud-puppy is undoubtedly an animal which should be developed as a human food. It is caught in great numbers by fishermen and instead of remaining a nuisance may be converted into a valuable asset. The first task should be the education of the general public concerning its value."

Pearse also describes the methods of capture by night and their relative abundance. Cleaned and skinned they would be as attractive in appearance as bullheads. As these animals are considered harmful to fish culture, to create a demand for them would be doubly advantageous. The hellbender, *Cryptobranchus*, our largest salamander, is worthy of consideration also, as a possible source of cultivated food.

Frogs as Food. In our studies of Oneida Lake fisheries (Figs. 156, 157) it was found that frogs were of considerable importance (Adams and Hankinson, '16). Many years ago Cobb ('04, p. 234) stated that in 1895, 60,000 pounds of frogs were taken about Oneida Lake. In 1915 one firm sold about 15,000 pounds.

Recently the natural history and utilization of the frog has been thoroughly discussed and summarized by Wright ('20), and his paper should be consulted for the detailed information and for references to the more important literature on frog culture. The subject of their productivity per unit of habitat yet awaits investigation.

Turtles as Food. Fresh water turtles abound on the shores of many streams and lakes, and as a source of food have not received much scientific study, although the wild crop has been utilized for many years, particularly near the large cities. These animals, as well as many others which thrive in shallow waters, are seriously threatened by the persistent tendency to drain the land.

The snapping trutle is one of the most important of the turtles as a source of food. Clark and Southall ('20, p. 5) state that in Iowa when hibernating, "as much as 5 tons of turtles have been taken from the various muskrat holes in one season. Our informant also stated that as many as 26 individuals have been found in one muskrat burrow, while at another time 1,420 pounds were obtained in one run. From 500 to 1,000 pounds of turtle were estimated as

a recent catch for one day." Kofoed ('03, p. 562) reports that the Illinois River produces annually 15,000 turtles. The Chicago market consumes 10,000 snappers per year (Clark and Southall, '20, p. 7). In a lake of 200 acres in Connecticut, Scudder ('17, p. 13) killed 135 snapping turtles. The Fishery Census of 1908 credited the Mississippi River system with producing 713,000 pounds of turtles and terrapins. Such figures of course do not include those used for home consumption, that never reach market.

Only one investigation has been found of the density of turtle population in a definite area. Pearse ('23) found that in Lake Mendota, at Madison, Wisconsin, there were on 546 acres 2,744 painted turtles, averaging 5 per acre, and 39 snappers, or .07 per acre. He considers the average for the painted turtle as fairly reliable, but not for the snappers on account of the small numbers available. By tagging them he learned that they were very sedentary.

In spite of the fact that the non-poisonous snakes have much the same influence as insectivorous birds in controlling the superabundance of insects in fields and forests, there is so much prejudice that a relentless warfare is carried on against them. Their numbers are declining rapidly on account of this, and because of the destruction of their haunts. Although snakes are used as human food in some countries there seems very little likelihood of our American species becoming important in this respect, for aside from the prejudice, the difficulties of breeding them in large numbers seem very serious. A number of years ago, Dr. Hubert L. Clark made some investigations of the edibility of blue racers (*Coluber*), and the results of his studies were published by Mr. Wells Harvey in a newspaper, the "Grand Rapids Press" (April 11, 1903, p. 10). In a recent letter, dated August 31, 1923, Dr. Clark thus summarizes his ideas on this subject:

"Regarding the question of snakes as food, considered seriously and not as a joke, I think there are two objections which make it unlikely that they can ever be of any economic importance, entirely aside from the universal and deeply rooted prejudice against them. In the first place, the amount of meat in proportion to waste (skin, viscera and bones, especially bones) on an ordinary 5 or 6 foot snake is too small to make the preparation and cooking worth while, and in the second place, large snakes are too rare to furnish any reliable supply of meat, even if the demand for them made their systematic hunting worth while. And snakes take so unkindly to captivity that it is very doubtful whether they could be artificially raised for the market. If pythons or boas are as good eating as



Fig. 161. Mule deer, a leading western big game animal, Yosemite National Park, California. Photograph by courtesy of A. C. Pillsbury.



Fig. 162. Elk in Yellowstone National Park. Photograph by M. P. Skinner.



Fig. 163. Bull moose and two calves, in upper Yellowstone Valley, Yellowstone National Park. A large game animal that retreats rapidly before settlement. Photograph by George Shiras, 3d.



Fig. 164. Mule deer of the Kaibab National Forest and Game Preserve, showing overbrowsed undergrowth under aspen. Photograph by courtesy of Albert Wilkes.

blue racers, and if their propagation in captivity could be made an easy matter, then I believe snakes might become a food source of economic importance." (Cf. Reese, '17.)

The preceding considerations show that in addition to the fish, other cold blooded vertebrates, the amphibians and reptiles, have on the whole, more importance than one might expect at first thought, although as yet largely a wild uncultivated crop growing on waste lands. Without question the productiveness of these animals could be greatly increased by careful investigation and intelligent management. This resource is worthy of serious study, and preliminary census studies, the determination of their rate of increase and detailed ecological life histories are of fundamental value in any such plan.

Game Productiveness. *General Considerations.* In the preceding discussion of the productiveness of fish it was seen that on account of the statistics of the fishing business and scientific and fish cultural studies we have a certain amount of detailed statistics which give a rough measure of fish productiveness. In general these are the most reliable data available on wild life productiveness. In dealing with the various kinds of game, there is, as previously mentioned, no commercial sale of game comparable to the fish business, and the game business is not recognized in the Federal Census reports as are the fisheries. Most of the game is handled by sportsmen and privately, and similarly uncertain is the amount of the private fish harvested. In some States an effort is made to record the numbers of part of the game killed, but it is well known that there is a large error in these records. It would require considerable investigation to learn the true value of this information as it is usually recorded in the various state reports. And yet while there is doubt as to their accuracy, there is no doubt but that they have considerable utility. The published figures are as a rule probably underestimates of the number of animals killed, but occasionally they are evidently overestimates, as in the case of Florida (Jones, E. Z., '15).

In this discussion of game no distinction is made between game produced for sport, for breeding stock, or for food, as these distinctions are not of importance here. The word "game" will be used in a broad sense to include all sorts of forest, water, shore and upland game birds, as well as wild rabbits and hares and even those fur-bearing animals whose flesh is suitable for food, even if not commonly used. This is a rather miscellaneous collection but it is all "game." The variety concerned is so large that only representative ones can be considered.

Water Birds. Among game birds, ducks are prolific, and are among the easiest to breed (Fig. 158). Originally they were exceedingly abundant, and with intelligent care great numbers can undoubtedly be maintained. A serious obstacle in the cultivation of all water animals, as previously mentioned in discussing fish, is the widespread impression that submerged lands should be drained as soon as possible, and be converted into farm lands. On the other hand there are large areas within forests, valuable for water storage and flood control, which can not and should not be drained. So long as the cultivation of the waters does not receive proper recognition and is economically neglected, largely through the lack of proper scientific study, this idea will naturally prevail. It is evident, however, that in forests there is not the same supposed urgency for drainage that is seen in regions of intensive tillage. (Cf. Saunders, '26.)

As an example of the possibilities of using shallow lakes for the production of ducks Mickle ('12, pp. 5-6) has published some interesting estimates of their available breeding area in northern Ontario. He secured from the Department of Lands an estimate of the submerged area. The water area varies greatly in different sections. For an area of 175,500 square miles, it was estimated that the water surface covered 19,290 square miles, or 12,345,600 acres, an area about equal to that of the forests in New York State. It is estimated that one-third of this area is suitable for the production of duck food; there is a total of about 2,800,000 acres of feeding grounds. Mickle further states that: "Observations extending over several years on one of the lakes of northern Ontario, showed that not less than two thousand ducks were supported on a possible feeding area of not over 1,600 acres, some of this being only sparsely supplied by weeds of any kind. One duck per acre could easily be fed on our northern lakes when the necessary plants are present, giving thus a possible crop of 2,800,000 ducks annually. A million ducks per year could therefore safely be killed without running any danger of depletion or extermination."

As Bryant ('14, p. 238) remarked after a survey of the California duck breeding grounds: "There is no reason why the mature crop of ducks should not be harvested yearly, just as the mature crop of timber is harvested. The same rational view as is accorded the administration of other national resources needs to be applied here. Supervision of natural nesting grounds and even a considerable expenditure of money to secure and maintain additional breeding grounds as game refuges would, therefore, seem to be justified.

More study in this direction will doubtless suggest other means by which our supply of native ducks can be increased."

Mickle's estimate of one duck per acre for Ontario is probably a fair number as will be seen by comparison with bird censuses mentioned later. The general plans for breeding ducks will also apply to geese and several other kinds of water birds. At present I know of no reliable estimates of the productivity of these birds. Leopold ('25) has made a seven-year duck census near Albuquerque, New Mexico.

The estimates of the annual kill of water birds are of considerable interest as a rough indication of their productivity. Avery ('21, p. 7; '22a, p. 1) has given the license returns from Minnesota for 1919, 1920, and 1921, and they show 1,805,000, 1,435,000 and 1,300,000 ducks respectively for these years. The records for geese were 2,300 for 1919, 1,800 for 1920, and 2,800 for 1921. Cole ('22, p. 57) reports for Manitoba 139,200 ducks killed in 1920.

Macdonald ('24, p. 91) reports the killing of 109,000 ducks for New York in 1918, 167,500 for 1919, 152,700 for 1920, and 180,700 for 1921. This report is certainly less than the number killed. Phillips ('23, p. 13), on the basis of 9,500 reported, estimates the killing of 125,000 ducks in Pennsylvania during 1921.

Swamp and Shore Birds. The shore birds, on account of the elongated character of their habitat, occupy an area comparable to that of small streams. I have not been able to learn of extensive estimates on their productiveness for unit areas, although Saunders ('14, p. 208) has estimated the number of marginal stream birds on 5 acres and found 12 birds—spotted sandpipers and killdeer. The records for woodcock killed in New York are given by Macdonald ('24, p. 91) for 1918, 19,200; for 1919, 27,800; for 1920, 25,700; and for 1921, 23,800. Hart ('21, p. 6) reports 3,100 woodcock for Virginia for the season of 1920, and for the season of 1922, 4,100. The annual kill of shore birds in Pennsylvania is given by Phillips ('23, p. 13) as reported by hunters at 1,800, and he estimates the total kill at 24,500. Avery ('22, p. 35) reports from Minnesota the annual kill of shore birds, coots, rails and gallinules as follows: (1919) 316,000; (1920) 152,700; (1921) 103,400 birds. The records of similar birds from New York, as given by Macdonald ('24, pp. 91-92) are as follows: (1918) 23,500; (1919) 34,500; (1920) 29,600; and (1921) 30,400.

Upland Game Birds. Of the upland game birds, the quails, grouse, pheasants and turkeys are the most abundant kinds. Some of these

abound only in the open forests, such as are grazed, and in such regions wild turkeys and western grouse and quail may be preserved, while other kinds live in the denser forests, or at the forest margins, as the ruffed grouse and eastern quail respectively. Estimates on the productivity of even the eastern quail or ruffed grouse are mainly estimates of the annual kill and a few census counts of birds.

The best information we have on bird censuses, to serve as a provisional basis, is given in the several bird censuses which have been made in recent years. Burns ('01), a pioneer investigator in this phase in America, studied carefully a square mile, about three fourths of which was cleared and the remainder in brush and forest, and found that in this area there were 1,388 breeding birds or 2.1 birds of all kinds per acre. He later ('14) repeated this census and found 1,424 birds per square mile, or 2.2 individuals per acre. Forbes ('07) reports a census made in the late summer and fall across the State of Illinois. His figures were secured during the fall migration and have little bearing upon the breeding birds of the region, but these counts have a certain comparative value. He records (l.c., p. 213) the density of population per square mile of swamp at 1,331 birds, or 2.08 per acre, and in rather open forests 785 per square mile, or 1.23 per acre. Quail are not migrants, to any marked degree, and in this census there were found 69 quails in 3,500 acres, or 1 quail to 50 acres, out of a total of 4,800 birds observed in the area. Forbes and Gross ('22) have shown that during the summer in Illinois quail are most abundant among shrubs and trees. Their paper gives the most extensive census of this species, and shows an average of 11 birds per square mile for the whole state (l.c., p. 214).

Avery ('22a) reports for Minnesota the killing of 6,100 quail in 1919, and 9,500 for each year 1920 and 1921. In Virginia, Hart ('21, p. 6) reports the killing of 166,500 quail, and in 1922 ('23, p. 99) 188,900. Phillips ('23, p. 13) records the reported killing of 9,600, and estimates the total killing of 125,300 for 1921. MacDonald ('24, p. 91) records the killing in New York (1918) as 9,000; (1919) 10,600; (1920) 5,700; and (1921) 6,000 quail. Jones ('15, p. 35) estimated the Florida quail population at 6,169,000 birds!

Finley ('13) made a valuable estimate of the numbers of prairie chickens in Illinois, and found that in the counties where farming was more intensive there was about one prairie chicken to 26 acres, while in the area of less intensive cultivation the average was about one bird to 4.5 acres. Avery ('22a) reports the killing of 231,000

prairie chickens in Minnesota in 1921, and Cole ('22, p. 57) for 1920, the killing of 36,800 prairie chickens in Manitoba.

The ruffed grouse kill (Fig. 159) is recorded for New York by Macdonald ('24, p. 91) as follows: (1918) 41,700; (1919) 48,700; (1920) 83,100; and (1921) 104,800. Phillips ('23, p. 13) reports for Pennsylvania the killing of 36,000 and estimates the total killed for the State at 470,400 grouse. Avery ('22a) gives for Minnesota in 1920 the killing of 501,500 grouse. Criddle (Hewitt, '21, p. 174) made a bird census in Manitoba on the prairie and in the woods, and found in 26 acres of woods, during 1914, '15 and '16, respectively, 11, 13 and 9 pairs of ruffed grouse.

The wild turkey is reported by Phillips ('23, p. 13) for Pennsylvania for 1921 with the record of 356 reported killed, and the state protectors counted 4,600 killed. Hart ('21, p. 6) reports the kill for the season 1920 in Virginia as 4,100 turkeys, and for the season of 1922, 3,900 of them, and Jones ('15, p. 35) estimated the turkey population of Florida at 38,100.

The English pheasants killed in New York, are given by Macdonald ('24, p. 91) as follows: (1918) 35,800; (1919) 46,200; (1920) 62,100; (1921) 77,300. For Pennsylvania Phillips ('23, p. 13) reports 2,900, and estimates 38,600 as the total killed. W. C. Adams ('21, p. 40) gives the number of pheasants killed in Massachusetts since 1914, and it totals 27,000.

Mr. Wells W. Cooke ('15, '16) has summarized two censuses of birds, based on counts of breeding birds in limited areas in various parts of the United States. His results show ('16, p. 5) that the average for the years 1914 and 1915 give a breeding bird population for 100 acres of isolated woodland as 187 pairs of birds. This gives 2,368 birds per square mile, or 3.7 birds per acre. While these evidences are not a satisfactory measure of game abundance they do serve as a very important background for comparisons. This shows that we can not on the average normally expect more than a few pairs of breeding birds per acre. Miss M. T. Cooke ('23) has summarized the results of bird censuses from 1916 to 1920, but this study gave but little data on game birds. The scarcity of birds in dense forests is clearly emphasized. Silloway ('23, pp. 435-438) made a careful census of areas of forest in the western Adirondacks and shows that in the Cranberry Lake forests the average is three pairs of birds per acre. His records show that in the burned area the birds were most abundant and fewest in the virgin forest.

Game Mammals. The variety of mammals which are abundant enough to be of much value, both as food and game, is not very

large. The amount of these produced, which in the aggregate is surprisingly large, is unfortunately not known. Raccoons, opossums, cottontails, jack rabbits, hares, muskrats, bear, and various species of the deer family, are the main kinds of wild mammals which are taken in large enough numbers to be of special value as food.

Muskrats are taken primarily for their fur, and the bodies of great numbers are discarded, but many are sold for food in the markets of the East and Middle West (Lantz, '17, p. 10). At present this amounts to a large waste which should be saved. Five thousand muskrats have been reported to have been taken from 5,000 acres of swamp (Lantz, l.c., p. 16). A 1,200-acre tract produced 12,000 muskrats in two seasons. The details for muskrat productivity have been discussed more fully in a special report in the *Roosevelt Wild Life Bulletin* by Johnson ('25).

Cottontails are extensively used for food, and in many regions they have been so extensively hunted as to require legal protection. Of the northern hares Seton ('17, p. 95) states that in Alberta during years of abundance: "They number not less than 100 to the acre on desirable ground, which means over 6,000 to the square mile, and a region as large as Alberta would contain not less than 100,000,000 fat white bunnies." He also states that ('09, p. 640): "I should say then that hares were very scarce when there was but 1 to the square mile of woods, and abundant when there was 1,000. I have, nevertheless, seen as many as 10,000 to the square mile." The fluctuating abundance of these hares is one of its remarkable traits, which makes frequent estimates, covering a series of years, desirable. For Canada there is an extensive record of the catch of hares in the records of fur sales of the Hudson's Bay Company. Seton ('17, p. 105) and Hewitt ('21, p. 217) have published this record which shows that in 1899 nearly 100,000 were taken.

In the case of the jack rabbits we have considerable information, largely from California. Palmer ('97, p. 24) records a rabbit drive with the killing, on an area of 48 square miles, of 25,000 jack rabbits, or about .8 per acre. On a square mile in nine days 8,000 jack rabbits were killed, or about 122 per acre. In another drive (l.c., p. 52) on 20 square miles 15,000 rabbits were killed, or about one per acre, and in another case (l.c., p. 56) on 1 square mile, about 4,500 were taken. With the extensive destruction of predatory animals in the West we may expect an increase in the number of rabbits. Rabbits might well be made a source of valuable food, as they have been in Australia, where the meat is canned in great quantities.

Palmer ('22, p. 6) has recently summarized an estimate of the annual kill of rabbits as follows: "Perhaps it is not too much to assume that the total number of rabbits killed annually in the United States is not less than four for each hunter, or a total of about 25,000,000." Phillips ('23, p. 13) has recently reported that for 1921 he estimated that over 5,700,000 rabbits were killed in Pennsylvania, weighing on the average 2.5 pounds, and making a total of 14,250,000 pounds of meat. If this killing estimate is true for Pennsylvania the chances are that Palmer's estimate for the United States is too low, and should probably be doubled.

Although great numbers of hares and rabbits are killed very little effort has been made to record their numbers. In Virginia Hart ('21, p. 6) reported the killing of 293,000 rabbits for the season of 1920, and for 1922 he reports ('23, p. 99) a total of 332,300. In Pennsylvania, Phillips ('23, p. 13) reports the killing by licensed hunters of 7,600 hares, and an estimated total killing of 100,400. In New York the license returns for hares are given by Macdonald ('24, p. 91) as follows: (1918) 36,100; (1919) 28,800; (1920) 43,600; (1921) 46,900; and for cottontails (1918) 465,500; (1919) 562,700; (1920) 508,200; (1921) 626,000. Avery reports for Minnesota ('22, p. 36) a catch of rabbits for the season 1920-'21 of 16,200, and for 1921-'22 of 38,800. Evidently both hares and rabbits are included in these figures. The shipment of Arctic hare skins from Alaska from 1912-1923 was 3,340.

We have little data on the Western States where jackrabbits abound, and furthermore without question there is an immense loss of both food and fur caused by the neglect of these animals. For details of the great destruction of rabbits by "drives," reference should be made to Palmer ('97).

Bears as a source of meat are not likely to increase greatly, yet they will thrive near man if given a reasonable chance. With regard to the black bear Seton says ('09, p. 1056): "As many as 30 bears have been killed in one year in Lewis County, N. Y., about 300 square miles (according to Merriam), and the inference is that this was unusually high—moreover, we know now that it was too much for their numbers to stand.

"I reckon that an animal breeding so slowly as the Bear could not stand a greater drain by man than 10 per cent per annum, therefore Lewis County must have had a Bear population of considerably less than 300. Yet this was considered an abundance." He estimates from the Hudson's Bay Company's catch that "therefore 30,000 will more nearly represent the annual kill on an area of

about 5,000,000 square miles. As during the time cited the supply has, apparently, not dwindled, it implies at least 300,000 bears, one to every 16 square miles." Seton (l.c., p. 1040) estimates that under the most favorable conditions grizzlies may average one to the square mile. Phillips ('23, p. 13) estimates 510 bears killed in Pennsylvania for 1921, at an estimated weight of 200 pounds, totaling 102,000 pounds. The Hudson's Bay Company records are given by Hewitt ('21, p. 233). Grinnell and Storer ('24, p. 64) estimate about 125 black bears in the 1124 square miles of Yosemite National Park, or about one to every 9 square miles.

Bears (Fig. 160) are usually considered game rather than as fur-bearing animals, and their skins are also valued as fur. As a predator, killing domestic animals, this seems to be largely an individual matter, a case of those which have learned a "bad habit," probably on account of the ease with which they can secure small and young or diseased domestic animals. Local estimates and killing records of bear are few in number. In Florida, Jones, ('15, p. 35) estimates over 3,000 for the State, a surprisingly large estimate. In Virginia the record of game killed for the season of 1920 (Hart, '21, p. 6) gave 117, and for 1922, 190 (Hart, '23, p. 99). Pratt ('19, p. 56) reports, from fur dealers, the killing of 40 bears for 1917-'18 in New York, and Carpenter ('21, p. 22) reports from hunting licenses in New York State the killing of 189 bears in 1918, and Macdonald ('24, p. 92) reports 324 in 1919, 232 in 1920, and 161 for 1921. Barber gives ('18, p. 17), from the Wisconsin trapping licenses, records of 32 bears for the season of 1918. For Minnesota, Avery ('16, p. 20) estimates an annual average killing of bears for 1915 and 1916 at 200, and reports ('22, p. 37) 68 for 1920-'21 and 87 for 1921-'22; probably the early estimates are much too high. In Maine, a tabulation from the Reports of the Commission of Inland Fisheries and Game, from the license reports, between 1910 and 1920, shows a range from 124 to 257 annually. In Ontario, McDonald states ('21, p. 7) that in the Province between June and October, 1920, 409 bear skins were exported or tanned. In the year 1921 ('23, p. 10) the total was 1,494 skins, and for 1922 there were 2,137. For Alberta, Lawton ('23, p. 78) reports 1,064 bear pelts on which taxes were paid in Alberta. Cole ('22, p. 59) reports 32 bears for Manitoba in 1920. Bell ('21, p. 299) reports 317 bears killed by the Biological Survey between 1915 and 1920, but this does not include those poisoned. The 1924 game census of the National Forests (see Table No. 2) gives 44,326 black bears and 5,624 grizzly bears.

The shipment of furs from Alaska gives some evidence of the bear catch there, although it does not of course indicate the number used in local consumption. This record has been summarized from the reports of the U. S. Bureau of Fisheries for 1912-1918, when supervision of these minor furs was turned over to the Biological Survey of the U. S. Dept. of Agriculture, and are now reported in the Annual Reports of its Chief (1919-1925). A summary of the data from these reports shows that between 1912 and 1923 there were 11,034 black bear, 430 brown bear, and 354 glacier bear skins shipped. Of the 408 grizzly and 329 polar bear skins the record is incomplete. The total number of bear skins shipped for this period is 12,555.

Deer have received much more attention than any other of our large game animals, and yet it is surprising how little on their productiveness per unit area is well established. Seton ('09, p. 77) estimated that the Adirondack Mountains contained about 30,000, or roughly 3 to the square mile, and for Maine he estimates 2 per square mile. He gives for Colorado 10 to 20 mule deer per square mile. He concludes that in primitive times there were 10 Virginia deer to the square mile. With the opening up of the forests by clearing, lumbering, fires, etc., the amount of food has been greatly increased (cf. Gaylord, '15) so that at present, or under supervision, an even larger number can be secured from a given area. Carpenter ('19, p. 21) estimated the number of deer in New York at 50,000 (cf. Pratt, '18, p. 33; '18a, p. 134) and the number killed in a season amounted to about 10,000. Macdonald ('24, p. 92) reports, from hunters' returns in New York, the killing of 8,293 bucks in 1918; for 1919 the bucks reported were 8,470, and does 3,444, or a total of 11,914; for 1920, 7,839 bucks; and for 1921, 9,065 bucks. Avery ('22a, p. 1) has summarized the annual kill of deer for Michigan, Wisconsin and Minnesota as follows:

STATE	1919	1920	1921
Michigan.....	25,000	27,000	12,500
Wisconsin.....	25,000	2,500	5,000
Minnesota.....	18,286	18,572	20,000
	68,286	48,072	37,500

This shows a total killed for all three states for three years of 153,858 deer.

Merriam ('09, Vol. 3, p. 324) summarizes the older estimates of the annual number of deer killed in Vermont, Maine, New York

and Michigan. W. C. Adams ('21, p. 46) gives the total number of deer killed in Massachusetts between 1910 and 1919, at 11,615; and Palmer ('22, p. 23) tabulates the kill of deer for Alberta from 1907 to 1918, with a total of 7,491, and (l.c., p. 38) the Vermont kill from 1897 to 1920 is given as 44,283.

Schenck ('09, p. 15) advocates limiting the number of deer in the Southern Appalachian forests as follows: "Compatible with the objects of silviculture are, per 10,000 acres, 50 head of elk or 150 head of Virginia deer, provided that nurseries are fenced." This would mean 1 elk for 200 acres, and 1 deer for 66 acres, or about 3 elk per square mile, and about 10 deer per square mile. In Pennsylvania Phillips ('16, p. 6) recommends for stocking a fenced area of four square miles 100 deer, at the rate of ten does to one buck, and calculates the annual increase of fawns at 150. Townsend ('16, p. 8) states that in Northern Michigan 750 acres will support 100 deer the year round in good condition. Shiras ('23) has pointed out the dangers of overstocking limited areas and the need of controlling the number of deer on such areas.

Hornaday ('14, p. 105) has expressed the belief that: "The unoccupied forest lands of the United States could in my opinion produce annually for our consumption at least 2,000,000 adult deer, without deducting more than \$50,000 from the wealth of the nation." There seems to be abundant reasons for believing that great numbers of deer can be produced on our forests, and that they are capable of adding much to the food supply, as well as greatly increasing recreation and income. Great numbers are regularly used for food illegally. Smith Riley ('15, p. 176) formerly District Forester at Denver, states that: "There is hardly a township of the 180 millions of acres of National Forest lands but what one-fifth to one-third is suitable only for game range. I mean by this that of this vast acreage, at least one-fifth to one-third cannot now, and can never, be used by domestic stock. This, of course, does not take into consideration the large areas now inaccessible that will eventually be used for stock grazing. To my mind, the fact that deer were fairly plentiful in the Uintah Forest of Utah during those years when the ranges were so heavily stocked with sheep that the animals came off the range in the fall poor, the existence of elk on the South Fork of the Rio Grande in the Rio Grande Forest of Colorado in the very heart of a range section that the cattle and sheep men fought over before the Forest was created, is ample proof there is room for the game as well as the domestic stock."



Fig. 165. Grassy park-like summer range of Kaibab deer, near DeMotte (V T) Park, Kaibab National Forest.



Fig. 166. Western part of winter range of Kaibab deer, Kaibab National Forest.



Recently Palmer ('22, p. 3) has made an estimate of the number of all kinds of deer killed, as follows: "The Biological Survey has published estimates for the years 1908, 1909, and 1910 of the number of deer killed in the States east of the Mississippi River, including Louisiana and Minnesota. The returns showed that in 15 states in 1908 the number was 59,878; in 1909, 57,494; and in 1910, in 17 States, 60,150. An estimate of the total number of deer killed throughout the United States in 1910 gave 75,000 to 80,000, and a similar estimate of the deer killed in 1915 showed about 75,000. The latter total, covering 36 States (all in which deer hunting was permitted), included abnormally large numbers killed in California, Connecticut, and Vermont, which were offset somewhat by a decrease due to closing the seasons in Colorado and North Dakota." (For an older estimate see Merriam, '09, p. 324.) With regard to elk, Palmer says ('22, p. 4): "Estimates made a few years ago showed a total of approximately 72,000 elk in the United States, whereas today it is doubtful if the number is much in excess of 52,000, of which about 25,000 are found in the Yellowstone National Park and adjoining regions."

The moose (Fig. 163) is local in its habits, so that relative abundance is more easily determined. Seton ('09, p. 155) states that for the vicinity of Winnipeg: "The area in question is about 500 square miles. According to these figures there is a moose population of around 1,000, or two to the square mile. This is what most hunters consider fairly good moose country, although a rate ten times as high is found in some localities. The entire range of the moose is about 3,500,000 square miles, but it is not all equally good; at a very rough estimate, we may put the number on the whole range at around a million of moose." Avery ('21, pp. 8-9) reports the killing of 359 moose for 1919, and 364 for 1920, in Minnesota. Hewitt ('21, p. 48) gives the number of male moose killed in Nova Scotia since 1909, and points out that in 1918, 1,243 were killed. He tabulates the kill for Alberta since 1907 and gives for 1917 a kill of 1,026 moose. Merriam ('09, Vol. 3, p. 324) tabulates the number of moose shipped in Maine between 1897 and 1906, and the total for this decade is 2,059. In the Annual Report of the Maine Commissioner of Inland Fisheries and Game for 1904 (p. 14, 1905) are also tabulated the numbers of moose and deer shipped by rail between 1894 and 1903. This gives a total of 1,722 moose, and 30,442 deer. Palmer ('22, p. 23) gives the Alberta kill of moose from 1907 to 1918, at 7,142. Palmer's ('22, p. 5) estimates for

moose are as follows: "This gives an area of about 16,500 square miles of moose territory in Maine, 28,000 in New Brunswick, and 18,300 in Nova Scotia, or a total of 62,800 square miles, a little less than the area of New England. In this region nearly 3,000 moose were recorded as killed in 1914, and probably at least 3,500 were actually killed that season. As each hunter is limited to a single moose, this indicates that more than 3,000 persons hunted moose, and on the average one moose was obtained on every 20 square miles."

In calculating the density of game population it is very difficult to make estimates per square mile of migrating species. Density estimates are of course needed for all seasons, but the season when the animals are normally scattered, as during the grazing season, is necessary to make comparisons with other grazing animals. This migrating habit is well marked in the elk, and especially in those which have been most carefully estimated as those of the Jackson Hole region of Wyoming (Preble, '11). It is estimated that between 20,000 to 25,000 elk winter in the Jackson Hole region; of these about 20 per cent summer in the Yellowstone (Fig. 162). It is estimated that these produce 5,000 calves annually. The number of elk in Yellowstone Park was counted by the cooperation of the Forest Service and the National Park Service in 1917, and the number found to be 19,345, or for its 3,348 square miles, about 6 per square mile (Potter, '17, p. 30; Lindsley, '17, p. 133).

The Forest Service has been experimenting for several years on methods of making a big game census of the National Forests (cf. Barnes, '24). Mr. Will C. Barnes, Assistant Forester, writes me as follows, under date of October 18, 1923:

"I enclose with this a cumulative summary of the big game animals in our National Forests. We have been making these reports for several years, but due to the inexperience of our men the first three or four year record was not complete enough to use it in cumulative form. Beginning with 1921, however, we felt that the figures were reasonably satisfactory. Beginning with the season of 1924 we will use a new sheet, which will be in the form of a ten-year cumulative record, so that at the end of 1923 the present three-year cumulative period will be closed. These reports as you will understand are based on estimates made by our field men. Nobody claims the summaries are absolutely perfect or that here and there mistakes in their observations may not have occurred. There is one thing about it, however, there is no other Government or State organiza-

TABLE No. 2. CUMULATIVE SUMMARY OF BIG GAME ANIMALS ON THE NATIONAL FORESTS 1921-1922-1923-1924 AND 1925.
FIGURES AS OF DECEMBER 31 OF EACH YEAR.

FOREST	ANTelope					BEAR					CARIBOU					DEER*					ELK					MOOSE					MOUNTAIN GOATS					MOUNTAIN SHEEP				
	BLACK OR BROWN					GRIZZLY																																		
	1921	1922	1923	1924	1925	1921	1922	1923	1924	1925	1921	1922	1923	1924	1925	1921	1922	1923	1924	1925	1921	1922	1923	1924	1925	1921	1922	1923	1924	1925	1921	1922	1923	1924	1925					
District 1																																								
Idaho:																																								
Clearwater.....																																								
Coeur d'Alene.....																																								
Kanawha.....																																								
Nez Percé.....																																								
Pend Oreille.....																																								
Sawtooth.....																																								
St. Joe.....																																								
Total for Idaho.....																																								
Montana:																																								
Abnaki.....																																								
Beaumont.....																																								
Brainerd.....																																								
Blackfoot.....																																								
Cabinet.....																																								
Deer Lodge.....																																								
Flathead.....																																								
Gallatin.....																																								
Helena.....																																								
Jefferson.....																																								
Kootenai.....																																								
Lewis and Clark.....																																								
Lolo.....																																								
Madison.....																																								
Minoula.....																																								
Total, Montana.....																																								
Washington:																																								
Kanikou.....																																								
Total for District 1.....																																								
District 2																																								
Colorado:																																								
Arapaho.....																																								
Battlement.....																																								
Cochesque.....																																								
Colorado.....																																								
Grand Mesa.....																																								
Gunnison.....																																								
Holy Cross.....																																								
Leadville.....																																								
Monterey.....																																								
Pike.....																																								
Rio Grande.....																																								
Routt.....																																								
Sage Lake.....																																								
San Isabel.....																																								
San Juan.....																																								
Uncompaghe.....																																								

[illegible]

1923 notes:	1924	1925	1926	1927
a. Closer estimate.				
b. Increase due to closer estimate.				
c. East Selway transferred from Lolo to Selway.				
d. Includes East Selway.				
e. On Forest entire year; main herd on Park Range.				
f. Increase.				
g. Decrease due to increased number of hunters and opening up new hunting grounds.				
h. 800 deer and 30 elk on Crater and Siskiyou, D-O, included in California totals.				
i. Increased rapidly.				
j. Error; no deer on Natural Bridge Forest, 1924 or 1925.				
k. D = Figures taken from annual grazing report where no fish and game reports were furnished.				
l. Numbers were furnished for 1925.				
	1924	1925	1926	1927
X Buffalo — District j N. C. Pisgah.....	4	7		
Oklahoma, Wichita....	160	184		
	170	191		

* Spend most of their time on range adjoining forest.
 † Includes 122 graziers.
 ‡ 1924 estimate probably too high.
 § Rapidly decreasing.
 ¶ No actual decrease; simply a more accurate estimate.
 †† Estimated number after deducting all elk killed by hunters and predatory animals.
 ‡‡ A low estimate.
 ††† Decreasing rapidly. Decrease in number estimated last year due to difference in opinions of Forest officers.
 ‡‡‡ 8,000 of these on foothills adjoining Forest.
 §§ Elk and deer increasing rapidly.
 ¶¶ Decrease probably due to poaching as elk were damaging crops.
 §§§ 1924 figures.
 †††† Including graziers, number not reported.



tion which covers so large an area of our country as the Forest Service, with so many trained men at its command, so that we feel that our record is unique, in that while here or there criticisms may be made, nevertheless nobody else is in a position to furnish facts to controvert our figures. Our men as you know are tremendously interested in game matters and are constantly striving to make their estimates very accurate and reliable."

This big game census, including the years 1921-'24, is presented in Table No. 2. Of the many valuable and interesting points summarized, attention is called particularly to the data for 1924. This shows that the number of antelope is 5,071, black bear 44,326, grizzly bear 5,624, caribou 82, deer, including white-tailed, black-tailed and mule, make a total of 550,567, elk 52,665, moose 5,106, mountain goats 17,244, and mountain sheep 12,433. This makes a total big game population of 693,128 animals, of which 550,567 are deer, and 142,551 are other big game. This shows that the National Forests today contain a very large per cent of the big game of the United States. It also shows the surpassing importance of deer, as big game. As will be noted, the table shows the game by Forest Districts, Forests, and by States. Without question this census is of greatest importance and should be continued and perfected, as is now planned, as this is without question our most important big game census, and shows in a very striking manner how intimately the wild life problem is connected with forestry, and furthermore, the responsibility which rests upon foresters in the care of this resource. The time is rapidly passing when the education of a field forester can be considered adequate without a general training in the wild life, grazing, predatory and rodent control, as fundamental in forestry training.

North of the Grand Canyon, Arizona, in the National Kaibab Forest is a large herd of mule deer (see Figs. 164-166). Table No. 2 gives 30,000 deer in this forest. Goldman and Locke ('23) have reported not less than 20,000 deer in this area. I visited this forest in August, 1924, and learned from "Uncle Jim" Owens, who for years has hunted cougars there, that he had for several years previous to 1913 estimated the number of deer there and that he calculated the number then to be about 35,000 "over all." The local forest ranger, Benjamin Swapp, who patrols the range of the deer, estimated upon the basis of counts made during both the summer and winter of 1921, that there were then between 40,000 and 50,000 deer, and by allowing for increase since estimated that there would be in 1924 between 60,000 and 70,000 of these deer. This indicates

how difficult it is to secure accurate estimates of such animals. This is without question the largest number of deer in a limited area within the United States. In spite of the importance of this herd there is very little dependable information published upon it, and some is certainly erroneous. Such an important herd should be exhaustively studied from every point of view, in order to make the "highest use" of it.

Millais ('07, pp. 333-334) says of the number of Newfoundland caribou:

"It is very difficult to figure out the number of caribou in Newfoundland, and all estimates must be mere guesses. Mr. Moulton of Burgeo, judging by the numbers wintering in the barrens north of that place and White Bear Bay, puts it at 250,000, and thinks they are increasing at the rate of 10,000 annually. Mr. Howley, on the other hand, places the figures at 100,000, and I think that double this number is a very fair estimate. In spite of the enormous slaughter which takes place annually, and which is every year greatly on the increase, Newfoundland will keep her deer for many centuries to come, if all shooters are licensed, and the number of deer shot by each person does not exceed three. Thus putting the death-rate at the highest estimate of three animals each to 4,000 shooters, 12,000 would be killed out of 200,000, that is a depreciation of 6 per cent. Now this is a much smaller rate of killing than takes place amongst the stags of Scotland, and they are undoubtedly on the increase. Ninety-nine per cent of the interior of Newfoundland is only fit for a caribou preserve, and the authorities now recognize this."

Dugmore ('13, p. 12) comments on the preceding as follows: "This is a hopeful view of the subject, and though his estimate of the existing numbers seems slightly high, there is every reason to hope that the animals will not decrease unless some entirely unforeseen condition arises."

Palmer ('22, p. 24) gives the following very important summary of the status of our big game, other than deer, as follows:

"From the foregoing partial estimates it is possible to approximate roughly the total number of big game other than deer in the United States. The figures in the following table should be regarded merely as maximum approximations and not in any sense accurate estimates.

ESTIMATES OF TOTAL NUMBER OF BIG GAME OTHER THAN DEER IN THE UNITED STATES

KIND OF GAME	1918	1920
Buffalo.....	2,700	3,400
Elk.....	72,000	52,000
Antelope.....	10,000	7,500
Moose.....	6,000	7,000
Mountain Goats.....	6,000	6,000
Mountain Sheep.....	11,000	10,000
Total.....	107,700	85,900

"This total of about 86,000 for 1920 covers only the big game south of the northern boundary of the United States, latitude 49°, and does not include the game of Alaska or of any part of Canada. Consequently, more than 50 per cent of the buffalo of North America are omitted from the statement, as are a considerable number of elk, the great herds of moose and caribou, and thousands of mountain sheep. Of the 3,400 buffalo, 1,032 are in Government herds, 111 are owned by States, and the remainder are in private hands." In this connection it is also well to recall the total amount of big game now found in the National Forests, to which reference has been made.

The buffalo has dropped from the class of important food animals, and it should be recalled that for fifteen years a careful annual census of it has been maintained by the American Bison Society. Their report for 1922-'23 (1923, pp. 21-27) contains a census as of January 1, 1923, by Garretson, giving 12,521 living specimens, of which 12,457 are in America, of which only 3,878 are in the United States.

This same report also contains, by the same author (l.c., pp. 48-51), a census of the pronghorn antelope, giving 10,099 for the United States, and 1,650 for Canada, or a total of 11,749. It credited no antelope to Arizona although Table No. 2, of game in the National Forests, shows for the State for 1923 a total of 1,179 antelope. The following information, dated March 18, 1924, from the Tusayan National Forest in Arizona, near the south rim of the Grand Canyon, has been kindly furnished me by Mr. J. E. Kintner, formerly a Forest Ranger on that Forest:

"During the summer of 1920 there were three small herds of antelope on this division of the Forest. One herd of 14 head ranged in the vicinity of Skinner Pasture, north as far as Lockett Lake and southeast as far as Mudersbach Tank. Another herd of

8 head ranged in Coconino Wash in the vicinity of Twin Tanks, westerly to Rain Tank, and in the open sage parks south of Coconino between the two mentioned tanks. The third herd of 5 head stayed in the vicinity of the Peterson Place and Woodbridge Tank and the open parks in that locality.

"The following summer 1921, a herd of 32 head ranged in the vicinity of Skinner Pasture, north and east. This herd stayed together until August, when they scattered into smaller herds drifting over approximately the same country as in 1920. The larger part of the herd remained near Skinner Pasture.

"During the summer of 1922, they seemed to be divided into three herds located the same as before, but the total number was smaller. The largest herd ranging Skinner Pasture consisted of nine head; the Peterson herd 4 head; the Twin Tank herd 5 head. During September, the Skinner herd dwindled down to two head, a doe and an old gentle buck. No others were seen during the fall except two does which had drifted as far north as Grand View Pasture near Grand Canyon Rim.

"Early in September, 1922, I rode onto the old gentle buck. He had bedded down about one mile northeast of Skinner Pasture and I found he had been shot through the left shoulder and though very stiff and sick he showed fight when aroused from his bed. I saw him several times during the remainder of the month and the early part of October. He was slowly recovering.

"After I moved to Anita during October I paid little attention to the Antelope until late in November. One evening while returning from Red Butte to Anita I noticed two antelope across the road ahead of me and following these, who should walk out of the cedars but the old buck still very lame in his left shoulder. This aroused my curiosity as to whether these antelope were not headed for winter quarters on the Cataract Plains.

"During January 1923, a trapper moved from Cataract to Anita. I inquired of him if he had seen any antelope. He had and estimated those ranging in the vicinity of the W Triangle Ranch on the Cataract to be about 60 head. His estimate corresponds to estimates of the cowboys who ride in the Cataract country during the winter, although the cowboys stated that larger herds of antelope ranged near Hilltop some twenty miles northwest of the W Triangle Ranch.

"From the information I collected from these cowboys the Cataract herd must total about 150 head. Whether most of these stay on

the Cataract year long is a question, though I am quite convinced that those ranging on this division of the Forest in summer, migrate to the Cataract Plains in winter and this migration is, no doubt, due to some extent, to the fluctuation of numbers on the forest during the past three years.

"I am also quite convinced that one of the worst enemies the forest herds have had were the homesteaders who were always coming to me with stories of the Indians killing antelope, but some of the homesteaders are, I believe, good runners up, due to the fact that antelope are easier to hunt and kill than deer and a cheaper risk than killing beef.

"Of the antelope I have seen on the Forest, I have never seen any that were not full grown. The bands are usually mixed, usually does and bucks, led by some larger buck. Their range is in the open, washes and parks in the yellow pine type."

Russell ('24, p. 46) has recently estimated the antelope of Nevada and puts the number at about 3,700. In the same paper he estimates the number of mountain sheep at about 585.

The Committee on the Conservation of Wild Life of the California Academy of Sciences has for several years compiled estimates of western big game. Some of these estimates have been published in the Annual Reports of the Academy and elsewhere (Calif. Fish and Game, Vol. 10, pp. 76-77, 1924).

The latest, most elaborate and careful census of the antelope has been made by Dr. E. W. Nelson ('25), of the Biological Survey of the U. S. Department of Agriculture, in which he gives 26,604 for the United States, 1,327 for Canada, and an estimate of 2,395 for Mexico, making a grand total of 30,326. The number is surprisingly large, but it will no doubt require considerable effort to preserve this species.

The preceding evidence shows that although we have only a fraction of the game that the country once possessed yet we have today a very considerable amount, which if placed under intelligent technical rather than "political" supervision, is sufficient to stock, in a very adequate fashion, the game covers of the country, and is capable of producing a large annual sustained supply of valuable game. The commanding position of the National Forests in game matters is evident.

Grazing Productiveness. *General Considerations.* Our National Forests are largely located in the West, in regions adjacent to the Great Plains or other extensive grazing lands, where the grazing

has long been a dominant industry. Great areas of these forests were open areas and furnished excellent forage, so that when they became National Forests the grazing industry (Figs. 167-169) was inherited with the land. This was a unique situation, that has grown wonderfully, so that today the officers of our National Forests are the largest administrators of supervised grazing forest lands. In 1922 the net area within these Forests was 156,837,282 acres, of which about 110,000,000 acres were suitable for grazing. This vast area has been producing an annual crop of forage for which there is a great demand. As a result a large modern industry is developing under rational management, and enough progress has been made to furnish us more reliable data on grazing productiveness than is available for either fish or game. It is easily seen that such estimates upon wild life and stock are much more difficult to make than on the rate of productiveness of timber and it will therefore require a much longer time to stabilize the estimates of animals. (Cf. Barnes, '26.)

Grazing Capacity. There is so much diversity in the climate, topography and vegetation of forest grazing lands that estimates of their yield in animal flesh are difficult to make, and must be mainly of local rather than of general value. As Jardine and Hurtt ('17, p. 13) have said of the semi-desert grazing lands: "Where so many variables are involved, it is obviously difficult to work out figures for carrying capacity which will insure 100 per cent efficiency in utilizing large areas of range. It is believed possible, however, to work out figures for the more prominent types of range which will serve as a safe guide in stocking a given unit, and in deciding the comparative value of different range areas.

"Within the Jornada Range Reserve was found range varying from that which will furnish yearlong feed for one mature animal on about 20 acres to that which will barely support a mature animal on, perhaps, 100 acres." In an area (the Jornada) of about 192,000 acres 4,632 animals (including horses) were grazed, an average of one head to 41.5 acres. The estimated carrying capacity of the whole reserve of 202,000 acres is 5,000 head, or at the rate of one head to 40 acres. These authors further state (p. 16): "Consequently, for a similar area of unfenced range in its present condition and development 50 acres per head would be a conservatively low figure, if the range and stock are to be kept in reasonably good shape." It should be borne in mind that these estimates are from grazing lands in general which are inferior to those of the managed ones of the National Forests. The averages (p. 17) for different



Fig. 168. Sheep grazing on the range of the Santa Fe National Forest, New Mexico. Photograph from the U. S. Forest Service.



Fig. 169. Counting sheep as they enter a National Forest to graze. Photograph from the U. S. Forest Service.

conditions of vegetation ranged from 20 to 59 acres per head per year, when fully grazed. Barnes and Jardine ('16, pp. 8-22) estimate the carrying capacity of public grazing lands to average one cow to about 22 acres, varying from 15 to 35 acres per head. It is customary to measure grazing capacity in cow units, the horse or mule being equivalent to a cow, and 4 or 5 sheep to one cow. Barnes ('13, p. 78) says:

"In estimating the carrying capacity of a range, it is generally agreed that a fair ratio between cattle and sheep is one to five; that is, a range which will support one cow will support five sheep. In feedlots it is generally admitted that the same amount of feed which will support one cow will take care of eight sheep. This is due of course to a closer cleaning up of the feed by the sheep.

"On many of the desert ranges it will probably require 100 acres to the animal to carry cattle the year around, while in the mountain ranges, where feed grows rapidly and there is a great variety of it, probably ten to fifteen acres is sufficient. In Texas on the staked-plains ranges they estimate that one cow or steer will require ten acres for year-around purposes, while on the eastern New Mexico ranges, where the sod is not so good, twenty-five to thirty acres are necessary to keep the range from being overgrazed and damaged. This is of course for year after year. In some seasons, due to unusual precipitation, the feed grows so fast and there is so much of it that a cow to every five acres will not begin to eat it off.

"On the prairies of Western Kansas and Nebraska they estimate that for year-around purposes between fifty and sixty head to the section (640 acres) is about the right number to keep the animals in good flesh and not overgraze the land. If used only in the summer season when the feed is growing rapidly the carrying capacity is greater than these figures indicate.

"On the sheep ranges in the higher mountains of Utah, Idaho and the rest of the Rocky Mountain states during the summer season, which is short—not over four months on an average—the ranges will and do carry as many as a sheep to the acre without being overgrazed. As a general thing, however, a sheep to every $2\frac{1}{2}$ acres is the safest rule. This of course must vary with the quality of the range.

"Goats eat so much brush that it is almost impossible to make a fair estimate of the capacity of a goat range, unless one goes over it carefully and notes the stand of the brush."

Jardine ('18, p. 635) also remarks that grazing capacity must be worked out for individual ranges, and cautions the use of average

figures worked out for larger areas. He gives the average acreage per cow as "about two acres per month." Former Acting Forester A. F. Potter of the Forest Service, writes under date of October 28, 1918:

"The average grazing capacity on cattle ranges has been found to be between 2 and 2.5 acres per head per month. On sheep ranges the average is about 9/10 acre per head per month. These figures are exclusive of the waste area. . . ." In a second letter of November 20, 1918, he continues:

"In 1907 the gross area of National Forest Lands, exclusive of Alaska and Porto Rico, was 145,856,835 acres. On this area a total of 1,200,158 cattle and horses and 6,657,083 sheep and goats were grazed. Considering 5 sheep or goats the equivalent of 1 cow the area quoted furnished 2,531,576 cow units of grazing. The average area per cow unit was 57.6 acres.

"In 1918 the gross area of the National Forests, exclusive of Alaska, Porto Rico and new National Forest areas in the East, was 154,118,967 acres, as corrected to June 30, 1918. During the fiscal year ending June 30, 1918, a total of 2,240,010 cattle and horses and 8,512,208 sheep and goats were grazed. Again considering 5 sheep or goats the equivalent of 1 cow the total cow units of grazing furnished was 3,939,516 with an average area of 39.1 acres per cow unit. A comparison of the acreage per cow unit for 1918 with that for 1907 shows an increase in carrying capacity of 47.3 per cent for 1918, as compared with 1907.

"The area of National Forests as given includes all lands within the respective Forest boundaries. The acreage for cow units includes barren, inaccessible and other areas of no grazing value. We have no reliable figures as to the actual area grazed. It has been estimated at 100 to 110 million acres. No attempt has been made in the foregoing computations to take account of the difference in length of grazing season. The time that the stock were on the Forest varied from approximately 60 days to yearlong. You will readily understand that such figures should be used only as a general measure of the grazing resources on the National Forests.

". . . It is our practice to consider 5 sheep or goats, or 2½ swine the equivalent of 1 cow or horse in converting the total grazing into an equivalent of cow units. Also, we use the total acreage of lands within the National Forests, rather than the National Forest lands only, in making our computations.

"To aid in increasing the production of livestock products during the emergency period resulting from the war, the number of

cattle and horses on the National Forests was increased by 385,000 and the number of sheep and goats by 625,000 between the spring of 1916 and July 1, 1918. This increase was possible as a result of accumulated improvement in the ranges of the National Forests and the accumulation of more accurate information which made possible the development and use of many small areas hitherto unused. It is entirely possible that a reduction in numbers of stock may be necessary for the proper protection of the National Forest resources, as soon as the existing emergency is over. It is believed, however, that the greater part of the increase in stock since 1916 can be taken care of permanently. The status of this increase is mentioned so that you will understand a possible reduction which may be made."

Detailed and prolonged studies have been made of the carrying capacity of grazing ranges in Arizona by Wootton ('16). He shows (pp. 21-39) that by measuring the total amount of dry forage per acre for several years there was an annual average of 1,160 pounds, or in round numbers 1,100 pounds per acre, which represents about normal activity. He converts this into grazing terms (p. 22) as follows: "Assuming that a steer eats the equivalent of 30 pounds of dry forage per day, he will need about 11,000 pounds of forage in a year. If the average annual production of the grassed area is 1,100 pounds of dry forage per acre, then assuming that it is safe to put on enough stock to eat half of that amount annually, the average carrying capacity will be 20 acres per head per year if the range is to be maintained at its highest productivity." See especially in this connection the studies made by Jardine and Anderson ('19), and Sampson ('23).

The unregulated public-domain range has deteriorated in places to 50 per cent below its full capacity (Barnes and Jardine, '16, p. 12), while at the same time that of the regulated National Forests has improved (p. 16) from 15 to 30 per cent, or an average of about 20 per cent. Jardine ('16, p. 300) states that outside of the National Forests public grazing land is "probably 25 per cent below what it was originally." Such facts show the value of intelligent management.

These preceding examples are estimates made by the leading authorities, and give a fair idea of the present status of the subject. They also show the sort of data which must, sooner or later, be secured for the wild life grazers and browsers in the forests in order to put their supervision upon a sound foundation.

In order to make concrete the magnitude of grazing in the National Forests I have secured through the kindness of Mr. Will C. Barnes, Assistant Forester of the Forest Service, a tabulation of the grazing allowances for 1913-1924 in the National Forests (Table No. 3), as follows:

TABLE NO. 3—SHOWING GRAZING ALLOWANCES IN U. S. NATIONAL FORESTS, 1913-1924

YEAR	Cattle and horses	Swine	Sheep and goats	Totals
1913.....	1,852,999	59,535	8,521,308	10,433,842
1914.....	1,891,119	65,645	8,867,906	10,824,670
1915.....	1,983,775	64,040	8,747,025	10,794,840
1916.....	2,008,675	58,990	8,597,680	10,665,354
1917.....	2,120,145	54,680	8,400,155	10,574,980
1918.....	2,359,402	51,685	8,937,837	11,348,924
1919.....	2,388,975	48,885	8,845,607	11,283,467
1920.....	2,373,638	49,320	8,554,282	10,977,240
1921.....	2,347,308	51,795	8,337,356	10,736,459
1922.....	2,278,693	27,210	8,044,857	10,350,760
1923.....	2,196,774	26,290	7,769,370	9,992,434
1924.....	2,110,953	25,880	7,431,565	9,568,398

Special attention is called to certain points, as follows: The total allowance for cattle and horses for 1924 is over 2,110,000, that of swine 25,000, and for sheep and goats 7,430,000, or a total of over 9,565,000 animals.

In District 7, which includes the Eastern National Forests, the number of cattle and horses is 32,700, of swine 14,100, and sheep and goats 9,600, or a total of 46,400 animals.

The actual number of stock grazed on each National Forest, for 1924 and 1925, is shown in Table No. 3a.

The cost of production of food animals on the western ranges has been made the subject of special investigation by the Forest Service (Barnes and Jardine, '16, pp. 26-50). We need similar information on fish and game production. Most of the experience is in the possession of a few technical and practical men, and there is much difference of opinion among them, so that there must be considerable investigation and experimentation before these questions can be understood. Grazing in National Forests, under regulation by the Federal officers, is so managed that its productiveness is much better than that of the formerly unregulated, competitive grazing on Public Lands. In other words, outside of the National Forests grazing suffers in a manner similar to that of the wild life within the National Forests, because of the lack of adequate Federal authority over the game.

FOLDOUT

The Canadian National Forest Reserves graze a considerable number of animals, as shown by a summary furnished me by Mr. E. H. Finlayson, Acting Director of the Canadian Forestry Branch, Ottawa, Canada. This table No. 4, covers the period from 1912 to 1922, and shows that grazing is progressing in the Canadian forests. For 1922, 53,600 cattle, 16,200 horses, and 8,200 sheep were grazed, or a total of 78,000 animals in these forests.

TABLE NO. 4—SHOWING NUMBER OF STOCK GRAZED ON CANADIAN NATIONAL FOREST RESERVES FROM 1912 TO 1922

FISCAL YEAR	Cattle	Horses	Sheep	Total
1912.....	90	5	.....	95
1913.....	160	.....	.....	160
1914.....	12,954	2,304	12,022	27,280
1915.....	12,923	1,870	9	14,802
1916.....	14,569	2,578	7	17,154
1917.....	18,774	2,498	6,619	27,891
1918.....	48,420	10,575	27,610	86,605
1919.....	66,798	16,945	15,618	99,361
1920.....	59,911	18,346	12,467	90,724
1921.....	58,938	18,502	10,952	88,392
1922.....	53,624	16,215	8,226	78,065

To state that our U. S. National Forests are producing forage for over 9,500,000 domestic animals shows that the forests are supplementing the tilled agricultural land in food production in a very important manner. When, however, we have 463,090,000 acres of forest under intelligent management there will be a considerable increase in their capacity to produce forage for both food and game animals.

The Reindeer Problem. The establishment of reindeer in Alaska in 1892 by Dr. Sheldon Jackson of the U. S. Bureau of Education, was done by private funds, and was later financed by the Federal Government, in order to build up a stable industry for the natives. This was a very important achievement, and is only partly recognized today by the public. Jackson ('97, p. 17) states that: "The vast territory of central and arctic Alaska, unfitted for agriculture or cattle raising, is abundantly supplied with the long, fibrous white moss, the natural food of the reindeer. Taking the statistics of Norway and Sweden as a guide, arctic and subarctic Alaska can support 9,000,000 reindeer, furnishing a supply of food, clothing and means of transportation to a population of a quarter of a million."

Jackson (cf. Georgeson, '04, p. 384) estimates that there are 14,000 square miles of reindeer pasture in Lapland, and 23 reindeer per

square mile. These estimates point clearly to a large potential food supply which may be secured from that vast Alaskan region. The publications of the U. S. Bureau of Education give detailed reports of the status of these animals which up to 1915 (see Bull. 1916, No. 47, pp. 16-17 (1917) had increased to 70,243 of which the natives owned 46,683. The average percentage of increase has been about 23 per cent for 13 years. By 1917 (U. S. Bur. Education Bull. 1918, No. 5, p. 14) the number of reindeer possessed by the natives had reached 67,448 and others owned 31,134, or a total of 98,582. Figures 170-173 illustrate phases of the Alaska reindeer industry. General accounts of the Alaskan reindeer have been written by Grosvenor ('03), and by C. J. Lomen ('19) and G. J. Lomen ('20), leading owners of Alaskan reindeer. Grenfell ('13, pp. 251-271) has given an account of the introduction of reindeer into Labrador.

In 1920 Congress authorized the establishment of a Reindeer Experiment Station in Alaska for the study of the reindeer problems. This was indeed a very important step and valuable results may be expected from its investigations. A first report by Hadwen and Palmer ('22) has been published giving a general reconnaissance of the situation. They estimate that there are now in Alaska between 130,000 and 200,000 reindeer, and that the grazing area of Alaska, between 150,000 and 200,000 square miles of range, will support between 3,000,000 and 4,000,000 reindeer. It will be noted that these estimates are less than half of Dr. Jackson's earlier figures. A preliminary map (l.c., p. 21) shows the present areas now occupied by reindeer, the unoccupied grazing grounds available, and the area of suggested "range reserved for wild caribou." As Dr. E. W. Nelson remarks in his introduction to this report (p. 4): "The reconnaissances already made indicate that the territory has available grazing sufficient to carry between 3,000,000 and 4,000,000 reindeer. The annual surplus from that number would yield a meat product each year worth more than the precious metals mined in the territory and second only to the fisheries as a permanent income producing asset."

The rate of increase of the reindeer given by Hadwen and Palmer ('22, p. 11) is as follows:

"The growth of the reindeer industry in Alaska in the period of 20 years from 1902 to 1921 shows an annual net increase of about 27 per cent, or, taking into consideration the estimated number of stock slaughtered during the period, an annual gross increase of about $33\frac{1}{3}$ per cent. This rapid increase from the small beginning in 1902 indicates a promising future. Swedish figures for reindeer



Fig. 170. Alaska reindeer, horns in the velvet, a new food resource for the far north. Photograph from Lomen Brothers, through Carl Lomen.



Fig. 171. A small herd of Alaskan reindeer. Photograph from U. S. Bureau of Education.



Fig. 172. General view of a large herd of Alaska reindeer. Photograph from Lomen Brothers.



Fig. 173. Reindeer venison ready for shipment from Nome, Alaska, to the United States. Photograph from the U. S. Bureau of Education.

place the herd profit, or net increase, in normal years at 25 per cent. The average fawn crop in Alaska runs between 50 and 60 per cent, although the average prolificacy of reindeer is indicated as about 70 per cent, with the highest percentage as 85 to 90."

The range requirement of each reindeer (l.c., p. 29) is stated as follows:

"From the surveys thus far made, it appears that the range requirement for each reindeer is about 30 acres. This closely approximates the acreage required by cattle on national-forest areas in the Western States, where it runs on an average about 2 to 2½ acres per cow per month, or roughly, between 20 and 30 acres a year. Some Norwegian figures give 25 to 28 acres a year in reindeer grazing. Specific observations thus far made on carrying capacity on two reindeer allotments in the vicinity of Unalakleet indicate 30 acres a year as a maximum requirement for mature animals exclusive of fawns. By including the fawns, on a basis of two fawns to one mature animal, the requirement becomes 26 acres a year."

There is an immense area in Alaska unsuitable for reindeer where the native Alaskan caribou will thrive if given adequate supervision. Probably the most striking fact brought out by the present investigation is the need of proper supervision of the Public Domain in Alaska. This region is now in a formative stage and a correct start is of the utmost importance. A modern system of land classification and of appropriate systems of utilization is the supreme need. The use of these grazing and forest lands should not repeat the blunders of our western forest and Public Domain grazing lands, but should profit by those expensive and wasteful experiences. Some comprehensive policy should be worked out which will protect the native Esquimaux and Indians, and at the same time provide for a rational development of the range and other resources by white men. The public will probably wish to have assurance that the true interests of the public will be sufficiently protected. It seems improbable, however, that the range interests can be properly supervised independently of the forests, game, fisheries, and other resources. At present the administration of these resources is scattered about in various Federal bureaus without a general comprehensive plan, and it would probably be unwise to provide for the range lands independently of other uses of the land.

Caribou. That there should exist today in America any wild animal suitable for food, in numbers at all comparable to that of the buffalo in its prime, is not only surprising but incredible to many persons.

And yet on the barren grounds of Canada, Seton ('17, p. 259) estimates that there were over 25,000,000 of the barren ground caribou in one herd. He says: "Yet it is possible that there are several such armies. In which case they must indeed outnumber the Buffalo in their palmiest epoch. . . . They number over 30,000,000 and may be double of that." [Between the Mackenzie River and Hudson's Bay.] When migrating (l. c., p. 258) they present a wonderful picture: "He [Buffalo Jones] stood on a hill in the middle of the passing throng, with a clear view ten miles each way and it was one army of Caribou. How much further they spread, he did not know. Sometimes they were bunched, so that a hundred were on a space one hundred feet square; but often there would be spaces equally large without any. They averaged at least one hundred Caribou to the acre; and they passed him at the rate of about three miles an hour." The normal increase of such a herd is capable of producing a vast amount of food. The shortage of meat during the War called public attention to these huge herds. Stefansson ('22, '22a), who had become acquainted with caribou and musk ox in the Arctic, has discussed the merits of these animals rather fully. Recently also a Royal Commission was appointed by the Canadian Order-in-Council, to report on the possibilities of reindeer, caribou and musk ox (cf. Rutherford, McLean and Harkin, '22). Much valuable information is assembled in their report. (See also Noice, '23.)

Relation of Grazing to Game. In addition to the domestic food-animals grazed in the forests there are also horses, mules, and various kinds of wild game, such as elk, deer, mountain sheep and goats, which graze or browse. Extensive areas are too rugged, too remote, and too small to be available for domestic animals and these may well serve for an indefinite period of time for wild game. The food and recreational value of these animals may well merit the exclusive reservation of certain areas for such animals. In solving the problems of the relation of domestic animals to the game the subject must be viewed broadly, from the standpoint of public welfare, and not from that alone of local and special interests.* Jardine and Anderson ('19, pp. 5, 71-73) state the case clearly: "The aim here

* When the establishment of a Grazing Service takes charge of the Public Domain, outside of other reservations, there should be complete control of such lands, including not only predatory animals (which are often game) but also wild life in general, and thus avoid the error made in the case of the National Forests. The Alaskan Arctic prairies should be recalled in this connection, as it may be the part of wisdom to include them in such a plan. Secretary H. C. Wallace has recently ('23) very wisely revived the agitation for a comprehensive policy for the range lands, but unfortunately without adequate provision for the wild life aspect of the problem. (Cf. Barnes, '26.)

is to make clear that protection and development of the wild life of the Forest must go hand in hand with the development and management of the range resources for use by domestic stock. . . . It is not intended that development of the grazing resources for use by domestic stock shall unduly restrict the development of game or interfere with its proper protection from loss due to lack of suitable forage. On the other hand, it is not intended that forage which might be used by domestic stock shall go unused for years if it is not needed by game. Each has its place in the development and use of the National Forest resources, and every forest officer should realize that he shares the responsibility of determining the proper relation between the two."

One of the most conspicuous examples of the relation of grazing to game is seen in the case of the elk which summer in Yellowstone National Park, and generally winter outside of the park on account of the deep snows which bury the forage there; the northern herd going into Montana north of the park, and part of the southern herd going south of the park mainly into the Teton National Forest or on private lands in the vicinity of Jackson's Hole. (Cf. Skinner, '25.) There is a division of authority over these animals, both the Federal National Park Service and Forest Service on one hand and on the other the States of Montana and Wyoming; and up to the present it has not been practicable to secure satisfactory cooperation, and the elk consequently suffer, and in the opinion of some they are in danger of extermination. Several plans have been suggested, and without question one of the possible solutions is to make the needed parts of the Teton and Shoshone National Forests a Federal game sanctuary, by making a large area a permanent State preserve, or possibly the best of all would be a joint agreement among these agencies. The most important studies published on this problem are the papers by Preble ('11), Graves and Nelson ('19), and Graves ('20). The problem of the Kaibab deer is similar. The whole subject awaits satisfactory investigation and the publication in detail of the basal data, as well as the conclusions.

During the summer of 1924 I visited a number of the National Forests in the Southwest and was keenly impressed with the paucity of game in most of the regions. (Cf. Leopold, '20, '20a; Adams, '25b.) Severe over-grazing was in evidence everywhere. The control of water for domestic animals controls vast areas where game could otherwise thrive. This over-grazing and over-browsing often leaves the winter range depleted as winter range for wild life. The

grazing on the Kaibab Forest is one important factor in the acute Kaibab deer situation. It is likewise evident near the south rim of the Grand Canyon in the Tusayan National Forest.

In the case of some of the National Parks the deer summer in the parks, and a part or even most of them migrate out of the parks to lower altitudes, often into National Forests or even on private land for winter range, as in the Yosemite. The deer must winter on land which has already been grazed during the summer, and thus the deer are in direct competition with grazing animals. In this case public and private interests are competing.

The question is often raised as to the relative value of wild life compared with that of the domestic grazing animals. In view of the fact that certain economists are emphasizing the over-production of agricultural products, as a serious cause of economic stress, may it not be worth considering whether or not these domestic animals should be reduced in forests where they are generally over-grazing, injuring the reproduction of the trees, and competing with wild life? Recently Mace ('22) has made some interesting calculations on the California National Forest. He estimated that 40,000 deer are getting year-long feed on this forest, but if winter deer range was increased by restricting the grazing the forest would probably carry 175,000 deer. He further estimates that 25,000 to 30,000 bucks could be killed each year from such a herd. These if averaging 75 pounds dressed, at 30 cents per pound or \$22.50 per deer, for 30,000, would mean a direct cash value of \$67,500 and now the maximum grazing fees paid the forest are less than \$15,000. Of course this does not include what hunters and tourists would spend in the region on the one hand or the sale value of the domestic animals on the other, but it does indicate that the value of game is much greater than many realize who are thinking solely in terms of grazing revenue.

The injurious effect of over-grazing by domestic animals is well stated by Grinnell ('24, p. 842): "You cannot make two things of the same biological predilections occupy the same space at the same time. There cannot, in my understanding of the situation, anywhere or ever be a so-called 'maximum' output of live stock and an ideally abundant output of wild animal life from the same area at the same time. Sheep and cattle, goats and hogs, are animals which introduce entirely new features into the organic interrelations in forests. Wild herbivores cannot compete with domestic herbivores on anywhere near equal footing. Livestock is taken into the lowlands in the fall after having stripped the forage from the mountains, and the native

herbivores are left there to do the best they can with the meagre residue at the severest season of the year. They starve, and their reproductive vigor is reduced. It is the food supply available at the season of least supply that determines the maximum amount of resident animal life that can exist. Take off most of, or all of, the grass, herbs and browse during the summer and there will be little or no crop of hay or seeds or fruits to carry the native wild animals through the winter and spring before the next crops grow."

There is another serious aspect, resulting in the presence of domestic grazing animals, in the forests and adjacent to our National Parks, and that is as carriers of contagious and other forms of disease. The "tame" herd of buffalo in the Yellowstone National Park has become infected with hemorrhagic septicemia, probably from domestic animals. The mountain sheep also became infected with scab from domestic sheep and this resulted in their almost complete extermination from large areas of the Park. During the summer of 1924 in California cattle carried the foot and mouth disease into the National Forests where it spread to the deer, and thus became a menace to the deer of the Yosemite National Park, as most of these winter outside of the park on grazed land. Figure 161 shows one of the healthy mule deer in the Park.

Because, however, the owners of grazing animals are well organized and powerful politically, their case has been strongly stated. And then of course the large revenue, amounting to millions of dollars—even though a full value has not in the past been charged—has also had its influence, during the period when the National Forests were not upon a self-supporting basis. The silviculturists were however the first to sound a warning about the injury done by grazing animals, and now those interested in wild life must repeat this warning, but from another angle.

Economists have stressed agricultural over-production as a factor in the present financial depression. They have also pointed out that what is needed is some system of control within the industry which will reasonably restrict over-production. This appears to be a more appropriate method than an aggressive policy toward extension of the range, over-grazing it, or striving, by political methods, to prevent payment of a reasonable grazing fee. Perhaps a part of this difficulty is due to the lack of an appreciation of the relative economic value of game, as was pointed out in the case of the California National Forest, and of the importance of a diversification of industries, which should be developed about the game resources.

PRODUCTIVENESS OF FUR-BEARING ANIMALS

Status of the Fur Industry. The destruction of forests, the drainage of the land, the methods of controlling large stock-killing predators, trapping, hunting, destruction of game vermin, the absorption of farms from the Public Domain, and intensive agriculture, have all combined to encroach upon the haunts of fur-bearing animals and to kill them. Modern furs are derived from both domestic animals, such as rabbits, and from wild animals, and in the present discussion attention will be given primarily to the wild life aspects of the problem.

During the war the center of the fur industry moved from Europe to America, where we also have today the largest fur consuming public as well as the largest business in raw and manufactured furs. This has given the whole subject of furs a new meaning and interest to Americans, and particularly to the people of New York State, as New York City is the center of this industry for the world. The excessive prices paid for furs during the war led to a period of overtrapping and great areas were depleted of their fur-bearers. But the financial depression following the war, with its low prices for pelts, has allowed to some degree the recuperation of the breeding stock. Leaders in the fur industry are now beginning to appreciate that the permanence of their industry, as a form of investment, depends upon a sustained yield of raw fur. This means there must be an application of the general principles of conservation to fur-bearing animals if the permanence of the industry is to be maintained (cf. Adams, '23). The fur industry has now arrived at much the same point as the lumber industry with its depleted forests, and the restoration and maintenance of the raw fur supply is the same general kind of problem as is the maintenance of forests, fish and game. The fur trade is merely one more of the industries, the latest, to realize the impending shortage of its wild raw product, and is just becoming really alert as to the true situation and becoming interested in conservation. As long as a supply of fur was forthcoming, there was little concern as to where it came from and how it was to be maintained. The restoration of the depleted supply will be a much quicker process than that of producing the slow growing tree crop but the two are bound up so closely that they will make best progress by working together, because the forests are today the main source of wild fur, and are likely to remain so for an indefinite period.

The decline of fur-bearing animals began with the original settlement of the country, and has advanced with it; and, as has been indicated for the forests, fish and game, the general and rather sudden appreciation of an impending shortage has just begun to be keenly appreciated with fur-bearing animals. We may expect, under the present economic pressure, to have a great demand for further knowledge as to how to breed, protect and utilize this resource. There will doubtless be the old tendency to seek immediate returns, but this is not the kind of a problem that will be solved by that method. As fur is largely the product of "waste lands," we must look, in the main, to the forests for its production, and forest policies are even today generally devised without recognition of this resource. In the 463,000,000 acres of forest lands, which the U. S. Forest Service estimates the country must develop under proper management to meet its economic and social necessities, it will be possible to produce a very large crop of fur-bearing animals. Wherever such forests will grow, fur-bearing animals will, under intelligent supervision, thrive and produce an annual crop of pelts. Likewise, just as a managed forest will produce much more timber than a wild forest, so forest lands managed to produce fur-bearing (and other) animals, will probably produce much more, even twice as much as the same area of wild unsupervised land. An ample sustained yield of raw fur is one of the greatest needs of the fur industry. Such a supply involves the coordination of many influences. Waste should be eliminated all along the line from production to consumption. There is no single, simple method of securing this, because it involves not only all the factors of production, but those concerned with utilization as well, according to a high economic and social standard. The first step, however, is a true understanding of the situation, and an intelligent plan for improving conditions.

Productiveness of Fur-bearers. The recorded estimates of the productiveness of fur-bearing animals share the same weakness as that pointed out for other wild life, and are at best, in most cases, only rough estimates, and often only guesses. Many of them are included in calculations already cited for game. The most important ones are here assembled to give a concise summary of our present knowledge. Those animals, already mentioned during the discussion of game, will be correspondingly slighted here. In the past a large part of the fur from wild rabbits was wasted, while other rabbit fur was imported from Europe and Australia (cf. Palmer, '97). This has been remedied in part, but there yet remains a great waste of

this fur. Great numbers of "game vermin" and other predators are killed without regard to the condition of the pelt, and this causes a great loss; a loss which in many cases would pay for the damage done, if killed during the cool season, when the fur was in prime. Some of these losses are unavoidable, and some are due to ignorance, prejudice and neglect. There is a vast loss caused by the prevalence of defective trapping laws and a failure to live up to the good ones. This causes a serious loss to trappers, the industry, and to the public. There is more or less friction between sportsmen and trappers, with regard to trapping seasons, and regarding the destruction of "game vermin." Part of this is preventable by educational methods and part depends on further scientific study of fur-bearing animals, in order that we may determine the best methods, how many, and the best season for trapping (Adams, '16a, b). Such losses as these, although extensive in the aggregate, largely escape the ordinary methods of estimating the number of animals killed.

The main sources of information on production are the few estimates made of the fur population, collected largely by naturalists and those interested in game and fur-bearers, the various records of the kill, and finally the statistics of the fur industry. The killing records consist largely of stock and game vermin, and the records of fur merchants, and the return from trappers' and hunters' licenses. The records from Alaska are those recorded by the Federal Government.

The annual reports of the Forest Service from 1909 to 1916 contain tabulations of predatory animals killed by officers of the Forest Service. On July 1, 1915 this work was transferred to the Bureau of Biological Survey, and the killing records are given to date in Dr. E. W. Nelson's annual reports. The results of these activities are given in Tables No. 5 and No. 6. A tabulation of the killing

TABLE NO. 5—SHOWING PREDATORY CONTROL AS CONDUCTED BY THE U. S. FOREST SERVICE BETWEEN 1909 AND 1915
(Data from the Annual Reports of the Forester)

DATE	Wolves	Coyotes	Mt. Lions	Lynxes	Wild cats	Bears	Totals
1909 — P. 27.....	206	3,295	96	81	571	108	4,357
1910 — P. 42.....	277	7,157	98	131	1,169	271	9,103
1911 — P. 56.....	241	6,487	88	72	870	213	7,971
1912 — P. 65.....	289	4,778	116	85	636	178	6,082
1913 — P. 36.....	161	3,541	133	62	583	206	4,686
1914 — P. 22.....	79	3,166	60	57	533	240	4,135
1915 — P. 15.....	56	3,163	29	45	361	189	3,843
Total for 7 years...	1,309	31,587	620	533	4,723	1,405	40,177

TABLE NO. 6—SHOWING PREDATORY CONTROL BY U. S. BIOLOGICAL SURVEY
July 1, 1915 to July 1, 1923

DATE	Appropriations	Sale of skins	Large wolves	Coyotes	Mt. lion	Lynxes	Bobcats	Bears	Total killed	Estimated total killed
1915-1916	\$125,000	.....	424	11,890	9	.....	1,564	.....	15,973	.....
1916-1917	287,000	\$36,000 00	556	22,342	107	.....	3,053	60	30,512	75,000
1917-1918	304,000	78,579 45	849	26,241	85	30	3,432	41	30,678	.....
1918-1919	375,000	76,128 56	584	27,100	149	43	4,123	81	32,080	32,000
1919-1920	272,000	42,048 00	523	21,558	189	10	2,987	94	25,361	.....
1920-1921	.....	8,509 00	694	24,234	129	.....	*2,466	88	27,611	50,000
1921-1922	.....	34,202 75	687	27,185	173	.....	*2,827	114	30,986	80,000
1922-1923	.....	34,839 00	599	25,622	158	.....	2,822	101	29,302	.....
Totals.	.....	\$310,306 76	4,916	186,172	999	83	23,274	579	222,503	.....

* Includes lynxes.

of predatory animals by the Forest Service shows that during 7 years they killed on the average nearly 6,000 animals annually, a total in round numbers of 1,300 wolves, 31,500 coyotes, 600 mountain lions, 500 lynxes, 1,400 bears and 4,700 wildcats, or a total of about 40,100 animals. When transferred to the Biological Survey, special appropriations were greatly increased for this work, even reaching \$375,000 in 1918-'19. In the past eight years the survey has averaged about 28,000 animals or over four times as many as were killed during the regime of the Forest Service, the total probably reaching 450,000 animals killed. The skins of these animals have, since 1915, sold for \$310,300. In round numbers this included 4,900 wolves, 186,100 coyotes, 1,000 cougars, 80 lynxes, 23,200 bobcats, 500 bears, or a total of 222,500 animals killed, and of course a great number were not recovered. In spite of the vast sums of money involved in this work it has contributed but little to our knowledge of this problem.

The publication of the detailed kill of large predators by bounty systems and other repressive measures would be of considerable interest but this has rarely been done. An excellent summary of the conditions in Canada is given by Hewitt ('21, pp. 193-206), including the annual killing of wolves and coyotes. In Saskatchewan over 34,000 coyotes were killed by this system in 1915. The destruction of small game vermin by the bounty system, as applied in Pennsylvania, has recently been discussed by Gordon ('23). (For discussions of various bounty systems see Palmer, '96; Lantz, '08; Kalbfus, '16, pp. 25-34; Hewitt, '21, pp. 198-204; and Ligon, '23, pp. 295-330.)

The remarkable periodic fluctuation in numbers of fur-bearing animals has long attracted attention. This is a subject of much

importance from the standpoint of productiveness, and particularly from that of securing a sustained yield of fur, because this means that we may anticipate that considerable attention will be given to stabilizing influences, in order to overcome this tendency. Seton ('17, pp. 103-106) and Hewitt ('21, pp. 213-234) have given attention to the subject, and have published valuable graphs showing the catch of fur by the Hudson's Bay Company's records, back to 1820. (See also Ashbrook and McMullen, '25.) Both Seton and Hewitt have drawn valuable general conclusions from their study of these tabulations, to which direct reference should be made. Other convenient sources of the Hudson's Bay Company's records of sales are given by Poland ('92) and J. W. Jones ('14, pp. 201-214).

The details of killing records, and estimates of some of the more important fur-bearers in recent years, will now be considered. In order to secure a definite idea of the status of annual fur production I have summarized available information on the annual catch of furs, and the killing records of certain predacious fur-bearing and game animals, which are also of some importance in fur production.

Opossum. As the opossum is largely a southern animal, and as most of the attempts to estimate game and fur-bearers have been in northern states, the estimate for Florida by Jones ('15, p. 34) is of special interest, although it is probably not more than a guess. He gives 276,600. The Virginian estimate of the annual kill, by Hart ('21, p. 6), is 43,400 for the season of 1920, and 68,200 (Hart, '23, p. 99) for the season 1922. Barber ('18, p. 17) reports from trappers' licenses in Wisconsin only 25 opossum from this northern state. Pratt ('19, p. 56) reports, from Mr. J. M. Cooper's estimate, the capture of 300 opossum in New York for the season of 1917-'18, and Macdonald ('24, p. 92) gives for New York during 1919, 848, for 1920, 375, and for 1921, 597 opossum killed.

Moles. Although mole skins are used in large numbers, most of them are imported, and almost no effort seems to be made to record our native catch. Barber ('18, p. 17) records from trappers' licenses 70 moles for Wisconsin, and in Maine a few have been recorded from license returns (Maine Rep. Inland Fisheries and Game, 1920, p. 47).

Wolves and Coyotes. Wolves and coyotes (Figs. 22, 23) abound now mainly in northern and western states, Alaska and Canada, and other British provinces. Barber ('18, p. 17) reports



Fig. 174. A representative catch of predatory animals, harmful to grazing animals, by a Forest Ranger, Arizona National Forest. Photograph from U. S. Forest Service.



Fig. 175. Coyote trapped in National Forest, as a part of the predatory control system. Photograph from U. S. Forest Service.



Fig. 176. Wildcat trapped in National Forest; a phase of predatory control methods. Photograph from U. S. Forest Service.

from trappers' licenses the killing in Wisconsin of 157 wolves and 13 coyotes for 1918. Avery ('16, p. 20) gives an average annual catch for 1915 and 1916 of 20,000 wolves for Minnesota. This estimate probably includes coyotes, and is probably high. (See Ligon ('23) for conditions in Michigan.) Hewitt ('21, pp. 193-204) has discussed rather fully the status of wolves and coyotes in the Canadian provinces. In British Columbia the bounty records show (l. c., p. 198) an increase in coyotes from 4,100 in 1914 to 17,300 in 1916. Cole ('22, p. 59) reports for Manitoba 2,100 wolves killed for 1920. Bell ('21, p. 299) reports the killing by the Biological Survey, between 1915 and 1920, of 2,900 wolves and 109,000 coyotes, but this does not include those poisoned. The Forest Service and the Biological Survey in 15 years have killed over 6,200 wolves and 217,600 coyotes, and between 1912 and 1923 there have been shipped from Alaska 1,600 wolf skins.

Foxes. Foxes are trapped for fur and to a much smaller degree are hunted for sport. They are extensively killed as enemies of game and poultry. More attention has been given to breeding foxes in captivity than any other fur-bearing animal. The number of silver foxes in captivity is estimated (Nelson, '22, p. 15) to be between 12,000 and 15,000, and it is estimated that 90 per cent of the silver foxes in the fur market are from ranch-bred foxes (Ashbrook, '23, p. 2. Cf. also Allen and Smith, '22).

From Wisconsin, Barber ('18, p. 17) reports from trappers' licenses the killing of about 1,800 foxes. Avery reports ('16, p. 20) for Minnesota an annual catch of 2,000, and a few are reported by him ('18, p. 29) from the Superior Game Refuge. His estimate from trappers' reports for 1922 ('22, p. 26) is about 4,000 foxes, and about 15,400 are the wild fox population for the state, and of all kinds of foxes in captivity there were 1,600. These in captivity result in an annual sale of about 400 pelts (l. c., p. 31). In New York Macdonald ('24, pp. 91-92) records the annual hunting and trapping record for red foxes as follows: (1918) 15,100; (1919) 14,600; (1920) 11,000; (1921) 12,400; and for gray foxes the corresponding numbers are 2,400, 2,900, 2,400, and 2,500. In Pennsylvania bounty records (Gordon, '23, p. 10) show that during about 7 years nearly 55,000 red and gray foxes were paid for. McDonald ('23, p. 10) records the tanning or exporting from Ontario in 1922 of 11,700 red fox skins, and Cole ('22, p. 59) reports for Manitoba for 1920, 148 white foxes, and 229 other kinds. Lawton ('23, p. 79) reports from Alberta taxes on about 3,500 foxes,

other than black foxes, and 192 of these. McMynn ('19, p. S19) reports from trapper returns in British Columbia for 1916-'17, 700 foxes, and for 1917-'18, 483 foxes, and Baker reports ('21, p. 66) from trappers' returns for 1920, 105 foxes.

The shipment of arctic foxes from the Pribilofs of Alaska, has, between 1909 and 1923, been 8,780 skins. From the Alaskan mainland between 1912 and 1923 the total shipment of all kinds of fox skins was 204,800.

Raccoons. The raccoon is hunted for sport, but seems to be more generally taken for its fur. In some states the hunting season permits its being taken with dogs before the fur is in prime condition, and then not only is its fur lost but in addition there is complaint that the dogs incidentally kill many skunks, and thus the total damage to fur is very serious. To a limited degree raccoons are bred in captivity and are sold for breeding stock, but the great bulk of the fur is from wild animals. The Florida estimate by Jones ('15, p. 35) places the raccoon population in that state at 258,200. The Virginia census of raccoons killed for the season of 1920, is placed by Hart ('21, p. 6) at 15,600, and for the season of 1922 (Hart, '23, p. 99) at 16,400. Barber ('18, p. 17) records for Wisconsin from trappers' licenses the taking of 4,600 raccoons. Macdonald ('24, p. 91) gives the following catch from trappers' reports for New York: (1918) 25,300; (1919) 18,300; (1920) 14,600; and (1921) 19,500. The Pennsylvania estimate by Phillips ('23, p. 13) is 77,300 raccoons killed for the season of 1921, of which only 5,900 were reported by hunters. McDonald ('23, p. 10) records from Ontario the tanning or exporting of about 12,000 raccoons skins in 1921, while in 1922 it reached to 20,300 skins. McMynn ('19, p. S19) reports from trappers' returns in British Columbia 627 raccoons in 1916-'17, and 654 in 1917-'18, and Baker ('21, p. 66) 1,300 in 1919-'20. In Minnesota Avery ('16, p. 20) reports an average annual kill of 5,000, and in 1919 he reports ('20, p. 22) 860 raccoons, and for 1922 ('22, p. 26) a catch of 2,000 raccoons, and of 282 (l. c., p. 27) held in captivity.

Marten. The marten (Fig. 179) is definitely recognized as solely a fur-bearing animal. In Wisconsin, Barber ('18, p. 17) records for 1918 from trappers' licenses, 48 pelts. For Minnesota Avery ('16, p. 20) estimates the catch for 1916 at 600 skins (this is probably over-estimated), and for the season of 1919 ('20, p. 23) he estimates a catch of 15. The estimated annual catch in 1922 ('22, p. 26) was placed at 50 skins, and the marten population for the state at 490

animals. The records of the annual catch in New York for "sable or marten," Macdonald ('24, p. 92) has given as follows: (1918) 823; (1919) 393; (1920) 123, and (1921) 186. For Ontario McDonald ('21, p. 7) reports exported or tanned 6,300 martens for 1920; for 1921 ('22, p. 8) 6,500; and for 1922 (23, p. 10) 7,300 skins. Cole ('22, p. 59) reports for Manitoba for 1920, 404 marten. Lawton ('23, p. 78) reports taxes from Alberta on 2,289 marten; McMynn ('19, p. S19) reports from trappers' returns for British Columbia in 1916-'17, 5,500 marten, and for 1917-'18, 5,000 skins; and Baker ('21, p. 66) 11,400 skins for 1919-'20. The shipment from the Alaska mainland for 1912 to 1923 amounted to 56,400 skins.

Wolverine. There are only a few records of capture and these are mostly Canadian. McDonald ('23, p. 10) reports for Ontario 12 for 1921, and 6 for 1922 as tanned or exported. Cole ('22, p. 59) reports for 1920, for Manitoba, 12 wolverine. Lawton ('23, p. 78) reports taxes in Alberta on 38 wolverine. McMynn ('19, p. S19) reports from trappers, 250 wolverines in 1916-'17, and 195 in 1917-'18 in British Columbia; Baker ('21, p. 66) reports for 1919-'20, from trappers, 247. The shipment from Alaska between 1912 and 1923 amounts to 1,600 skins.

Fisher. Avery ('16, p. 20) records the capture of 800 skins for Minnesota (probably an over-estimate), and later ('22, p. 26) reports 200, estimating 2,180 animals for the fisher population for the state. Barber ('16, p. 17) reports for 1918, from trappers' returns, 559 fishers from Wisconsin. McDonald ('23, p. 10) lists for Ontario as tanned or exported: (1920) 4,000; (1921) 2,600; (1922) 2,600. Macdonald ('24, p. 92) reports trappers' records for New York as follows: (1918) 396; (1919) 353; (1920) 132; and (1921) 186. Cole ('22, p. 59) reports for 1920 in Manitoba, 47 fisher. Lawton ('23, p. 78) reports taxes on 31 fisher for 1922, and Baker ('21, p. 66) records trappers' reports for 1919-'20 from British Columbia on 586 skins.

Weasels or Ermine. Weasels are abundant and are considered vermin by sportsmen and are valued as fur. Barber ('18, p. 17) records for 1918, from Wisconsin trappers' returns, 14,800 skins. For Minnesota Avery ('16, p. 20) estimates 200,000 skins taken, in number only exceeded by the muskrat; and the same estimate is given later ('22, pp. 26-27) when he estimates a total weasel population of the state at 400,000. Pratt ('19, p. 56) reports the estimate

of Mr. J. M. Cooper of 2,500 ermine skins for the season of 1917-'18. For the season 1918-'19, Mr. Cooper made an estimate for me of 10,000 skins, and for 1923-'24, 5,000 skins. Macdonald ('24, pp. 91-92) makes no record of weasels in New York. Gordon ('23, p. 10) reports bounties paid in Pennsylvania on 327,400 weasels in about 7 years, and expresses the opinion that this represents only about 25 to 30 per cent of those killed. The Ontario records of McDonald ('23, p. 10) give as exported or tanned 58,900 for 1921, and 94,400 for 1922. Cole ('22, p. 59) reports for 1920 in Manitoba 400 ermine. Lawton ('23, p. 78) reports for Alberta in 1922, taxes on 46,200 weasels. McMynn ('19, p. S19) reports from trappers for 1916-'17 in British Columbia 11,400 weasels and for 1917-'18, 13,100 skins, and Baker ('23, p. 66) reports for 1919-'20, 43,400 weasels. The shipment from Alaska between 1912 and 1923 amounts to 102,900 ermine skins.

Mink. Mink are generally recognized by sportsmen as game vermin and in some cases, as in Pennsylvania, bounties are paid for them. It is recognized also as a very valuable fur animal, and stands high in the numbers annually secured. Barber ('18, p. 17) for Wisconsin lists it third in the return of trappers' licenses. It is only exceeded by the skunk and muskrat. The return for 1918 gave 22,800 skins. Avery reports ('16, p. 20) the annual catch for Minnesota at 12,500, and for 1919 ('20, p. 23) he estimates a total catch of about 17,000 skins, and the license reports gave 5,600. He estimates ('22, pp. 26-27) the annual catch at 50,000 skins, and that there are 200,000 in the state. The New York records of mink (Macdonald, '24, p. 91) taken from trappers' and hunters' reports are as follows: (1918) 8,900; (1919) 9,800; (1920) 6,600; (1921) 11,200 skins. In Pennsylvania (Gordon, '23, p. 10) reports bounties paid on over 26,000 mink in about 7 years and is of the opinion that 25 to 30 per cent are killed in addition to those paid for. In Ontario mink (McDonald, '23, p. 10) were exported or tanned to the number of 33,600 in 1920, 42,600 in 1921, and 78,400 in 1922. Cole ('22, p. 59) reports for Manitoba 2,600 mink for 1920. Lawton ('23, p. 78) reports taxes for 1922 on 10,100 mink from Alberta. McMynn ('19, p. S19) reports from trappers in British Columbia for 1916-'17, 2,900 skins, and for 1917-'18, 2,400 skins; and Baker ('21, p. 66) reports 5,300 mink for 1919-'20. The Alaska shipments between 1912 and 1923 amounted to 337,600 skins.

Skunks. The skunk on account of its great value as a fur-bearer and its less aggressive habits toward poultry and game than the

mink and weasel is given more protection than these animals (cf. Lantz, '14). Jones' ('15, pp. 34-35) estimate of the skunk population in Florida is placed at 291,000 animals. The only other similar estimate is that of Avery ('22, p. 27) who gives for Minnesota 305,000 skunks. Avery ('22, p. 26) places the annual catch of skunks at 85,000. Barber ('18, p. 17) gives the 1918 annual catch for Wisconsin at 50,300 skins. McDonald ('23, p. 10) gives for Ontario the record of tanned or exported skins for 1921, as 47,100; for 1922 as 73,200. Macdonald ('24, p. 91) reports from trapper records: (1918) 187,700; (1919) 213,000; (1920) 149,800; and for 1921, 155,000 skins. Pratt ('19, p. 56) reports Mr. J. M. Cooper's estimate for New York during the season of 1917-'18 as 250,000 skunk skins. Mr. Cooper has prepared for me an estimate for 1918-'19 giving 260,000 skins, and for 1923-'24, 175,000 skins. Some attention has been given to breeding skunk in captivity, and Avery ('22, p. 27) estimates that 375 are thus held in Minnesota. Cole ('22, p. 59) reports for Manitoba for 1920, 1,000 skunks. Lawton ('23, p. 78) reports from Alberta in 1922 taxes on 3,100 skunk. Baker ('21, p. 66) reports from trappers in British Columbia in 1919-'20, 185 skunk.

Otter. On account of its aquatic habits and evidently its intelligence it persists remarkably after the settlement of a region. Its skin is valued highly. Jones ('15, pp. 34-35) estimates the otter population of Florida at 28,400. Avery ('22, p. 27) estimates for Minnesota 2,000 animals, and in his earlier report ('16, p. 20) gives an estimate of the annual catch at 500. Macdonald ('24, p. 92) gives the following trappers' records for New York: (1918) 591; (1919) 258; (1920) 126; and for (1921) 221. The Ontario records by McDonald ('23, p. 10) give as exported or tanned (1920) 4,000; (1921) 4,700; (1922) 5,300 skins. Cole ('22, p. 59) reports for Manitoba 76 otter for 1920. Lawton ('23, p. 78) reports taxes in Alberta in 1922 on 145 otter, and McMynn ('19, p. S19) reports from trappers for British Columbia in 1916-'17, 236 skins, and for 1917-'18, 190 skins; and Baker ('21, p. 66) for 1919-'20, 245 skins. The Alaska shipments from 1912 to 1923 total 18,600 land otter and only 7 sea otter.

Cougar. The mountain lion or cougar has been exterminated over a large part of Eastern United States. The records of its later history in New York are found summarized by Miller ('99, pp. 337-339). His tabulation shows that 107 were killed and \$2,140.00 were paid as bounties. The tabulation, Tables Nos. 5-6, of the predators

killed by the Forest Service and the Federal Biological Survey between 1909 and 1923, total 1,600 cougars. Bell ('21, p. 299) lists 540 cougars killed by the Biological Survey between 1915 and 1920, but this does not include those poisoned. Hewitt ('21, p. 198) summarizes British Columbia experience in killing cougars as follows: (1914) 280, (1915) 235, and (1916) 221.

Wildcat. Jones' estimate ('15, pp. 34-35) of the wildcat population of Florida is put at 32,200, and Avery ('22, p. 27) makes an estimate of 3,000 for Minnesota. He also estimates (l.c., p. 26) an annual kill of 600. At an earlier date ('16, p. 20) he reports an annual catch of 1,000 skins (probably an over-estimate). Barber ('18, p. 17) gives for 1918 a catch of 30 skins for Wisconsin. Macdonald ('24, p. 92) lists the trappers' records for New York as follows: (1918) 159; (1919) 697; (1920) 338; (1921) 226. Gordon's ('23, p. 10) record of Pennsylvania bounty reports gives over 3,000 bobcats in about 7 years, and considers that this probably represents less than about one-fourth of the number killed. McMynn ('19, p. S19) reports from trappers in 1916-'17 for British Columbia, 88 skins, and in 1917-'18, 195 skins; and Baker ('21, p. 66) for 1919-'20, 149 skins. The Forest Service and the Biological Survey between 1909 and 1923 killed 27,900 bobcats, the reports including some lynxes.

Lynx. The lynx is distinctly on the decline in settled regions. Avery ('16, p. 20) reports an annual catch in Minnesota of 500 skins, later ('22, p. 26) of 300 skins, and estimates the total population for the state at 1,000. Barber ('18, p. 17) reports a catch of 19 skins for Wisconsin. McDonald ('23, p. 10) reports as exported or tanned 591 skins in 1921, and 836 in 1922, for Ontario. Lawton ('23, p. 78) reports taxes on 3,200 for 1922, in Alberta, and McMynn ('19, p. S19) 4,300 for 1916-'17, and 2,400 for 1917-'18 from British Columbia; and Baker ('21, p. 66) reports from trappers 1,200 for 1919-'20. Bell ('21, p. 299) reports that the Biological Survey, between 1915 and 1920, killed 15,300 bobcats and lynxes, but this does not include those poisoned. The Forest Service and the Biological Survey killed between 1909 and 1923 over 600 lynxes, and some were lumped with bobcats. Between 1912 and 1923, 78,300 lynx skins were shipped from Alaska.

Alaska Fur Seal. A condensed tabulation of the Pribilof fur seal from 1909 to 1923 has been kindly furnished me by the U. S. Bureau of Fisheries; see Table No. 7.

TABLE NO. 7 — CENSUS, CATCH AND VALUE OF FUR SEALS, PRIBILOF ISLANDS, FOR FIFTEEN YEARS, 1909-1923

YEAR	Census	Catch (calendar year)	Value
1909.....	133,997	14,382	*.....
1910.....	132,279	12,964	\$437,327 07
1911.....	123,600	12,138	425,088 95
1912.....	215,738	3,191	113,223 76
1913.....	268,305	2,406	82,861 62
1914.....	294,687	2,735	123,397 07
1915.....	363,872	3,947	147,986 75
1916.....	417,281	6,468	280,780 73
1917.....	468,692	8,170	506,143 75
1918.....	496,432	34,890	3,077,350 62
1919.....	524,235	27,821	880,172 50
1920.....	552,718	26,646	864,652 56
1921.....	581,443	23,681	Some unsold
1922.....	604,962	31,156	" "
1923.....	653,008	15,920	Unsold
Total.....	.....	226,515	\$6,938,985 38

* Government's share of 1,161 skins sold for \$39,137.61. Balance of skins belonged to leasing company.

The table shows the census or estimates of the seals, the number killed each year, and their value, to which reference will be made later. The table shows the progressive increase in the herds, showing that in 15 years over 226,500 seals have been taken, and in 1923 there were killed 15,900 seals. Since the purchase of Alaska these islands have produced \$58,000,000 worth of sealskins (Brooks, '25, Ann. Assoc. Amer. Geogr., Vol. 15, p. 177).

Muskrat. As the muskrat is the leading fur-bearing animal of America the status of it is of special interest. The Virginia census of game killed for the season of 1920 (Hart, '21, p. 6) gave 70,400, and for 1922 (Hart, '23, p. 99) 82,700 skins. Barber ('18, p. 17) reports for 1918 from Wisconsin trappers, 802,000 skins. Avery ('16, p. 20) estimates muskrat skins taken at 3,000,000. (This is probably an over-estimate.) In 1920 ('20, p. 23) he gives trappers' reports at 50,900, and estimates that 152,700 were taken by all trappers. He later estimates ('22, p. 26) the number taken at 300,000, and places the population for the whole state at 500,000 animals. The New York records from the trappers (Macdonald, '24, p. 91) are as follows: (1918) 400,000; (1919) 307,700; (1920) 154,000; and (1921) 192,300 skins. The Ontario records (McDonald, '23, p. 10) are: (1920) 434,000; (1921) 479,800, and (1922) 554,800. These are records of pelts tanned or exported. Cole ('22, p. 59) reports 87,800 for Manitoba for 1920. In Alberta Lawton ('23, p. 77) reports 742,400 muskrat skins for 1922. In British Columbia McMyynn ('19, p. 519) reports 16,000 for 1916-'17, and 13,400 for 1917-'18. Baker ('21, p. 66) records from

trappers' licenses 46,100 muskrat skins for 1919-'20. Between 1912 and 1923 there have been shipped from Alaska 1,785,800 muskrat skins. Dixon ('22, p. 141) reports a catch of 25,000 skins in 1919-'20 from the Imperial Valley of California, and gives careful estimates of the number of muskrats per mile of stream and ditches (cf. Johnson, '25).

Squirrels. The squirrel population of Florida is given by Jones ('15, pp. 34-35) at 5,744,000. The annual kill for the season of 1920 in Virginia is given by Hart ('21, p. 6) at 108,500, and for 1922 (Hart, '23, p. 99) 125,500. Phillips ('23, p. 13) reports the killing of 63,000 and estimates a total kill for Pennsylvania of 824,700. The New York record by Macdonald ('24, p. 91) of squirrels killed are as follows, for grays: (1918) 126,000; (1919) 147,000; (1920) 175,000; (1921) 143,800; for fox squirrels: (1918) 8,400; (1919) 11,700; (1920) 9,400; and 1921, 7,500. Without question the pelts of a great number of squirrels are not saved by sportsmen. Between 1912 and 1923 there have been shipped from Alaska 11,000 squirrel skins.

Beaver. The beaver (Fig. 180) was extensively over-trapped for years but under protection it is rapidly increasing. Avery ('22, pp. 26-27) estimates a total catch of 8,000 beaver for Minnesota, out of a total beaver population estimated at 12,000. Avery ('22, p. 25) reports for the season of 1920-'21, 1,230 beaver were trapped, and for 1921-'22 a total of 3,500. Barber ('18, p. 17) reports that a special license for certain counties in Wisconsin for 1918 produced 537 beaver skins. Johnson ('22, pp. 163-166) estimated upon the basis of careful field studies, that there are about 8,000 beaver in the Adirondacks. His estimates are much more conservative than other published records. For Ontario McDonald ('23, p. 10) records, as exported or tanned, the following: (1920) 96,000; (1921) 95,400; and (1922) 93,900. In Manitoba about 662 beaver were reported by trappers for 1920 (Cole, '22, p. 59). In Alberta for 1922, 442 beavers were trapped (Lawton, '23, p. 77). McMynn ('19, p. S19) records for British Columbia during 1916-'17, 7,100 beaver, and for 1917-'18, 5,900. Between 1912 and 1923 there have been shipped from Alaska 28,000 beaver skins. Riley ('21, p. 5) estimated that in the Cochetopa National Forest in Colorado, a forest of 900,000 acres, there were 12,000 beavers in about half the area suited to them (cf. '21a). Rose ('23, p. 5) has recently estimated the beaver population of the National Forests of Colorado at 39,340. And commenting on this Mr. Will C. Barnes of the Forest Service

adds in a letter of December 5, 1923: "Probably, in round numbers, there are fully 60,000 to 75,000 beaver in the State of Colorado. The estimates for New Mexico show about 20,000 for that State. Everywhere they are increasing."

Methods of Increasing Fur Production. The prevention of waste in trapping is one of the methods which will greatly increase the available amount of raw fur, although, of course, this is not direct production, which consists in increasing the number and quality of these animals.

Trapping is generally carried on by such primitive methods that the trapper seldom knows how many fur-bearers his region contains or how many he should kill. There is often considerable competition among trappers so that there is a marked tendency to catch all that they can, because, as they see it, if any breeding stock is left the competitor will catch it. This is a repetition of the same warfare that formerly characterized the cattle and sheep industry when competing for pasture on the Public Domain, before the Forest Service took part of it over, and established a regular system of management; and it applies today to the open range on the Public Domain. The education of trappers to some system of trapping management for private and public lands would do much to eliminate the present chaos. The methods of increasing fur production are in urgent need of detailed scientific study by both field studies and under controlled conditions of an experiment station.

The most conspicuous departures from the usual chaotic methods of fur production, are those now practiced by the U. S. Bureau of Fisheries, in its management of the fur seals of the Pribilof Islands of Alaska. In the old days there was a free-for-all scramble for fur seals and naturally much friction arose between the British (Canadian), American (U. S.), Russian, and the Japanese seal hunters. This contest for seals on the high seas led to so much trouble that it threatened the extermination of the seals. In 54 years their numbers became reduced from four millions to 132,200 in 1910. As a result of these quarrels, and finally because of the threatened extinction of the herd, the various governments concerned have made detailed investigations of the seals. As a result of the various investigations there has probably been more written about these seals than about any other large wild mammal. The fur seal herd, as a result of investigations, and by their practical application to it, is now managed by the U. S. Government, and the dressed skins are sold at auction and 15 per cent of the profits are turned over to each, the

British and the Japanese governments (cf. Fur-seal Convention, 62d Cong. 2d Sess., House Doc. No. 916, 1912), as their share in this international fur business. The seals are now counted each year, the young are branded, and a system of killing a certain number each year is practiced. The census for 1923 gave 653,000 seals, of which 15,900 were killed. This is practical management by the preserve method. On a small scale, similar preserve methods are applied to arctic or blue foxes and 8,700 have been taken between 1908 and 1923. This seal problem is perhaps the most scientifically managed phase of extensive wild life breeding, conducted by the preserve method, in America, and illustrates what may be expected of other phases of wild life management, as time advances, in large forest areas, where the preserve method is particularly suitable (cf. Osgood, Preble and Parker, '15).

On account of the paramount interest of the Dominion Government in the native population of northern Canada, Dr. Hewitt suggests ('21, pp. 261-262): "A careful consideration of the problem of our northern fur resources and the position of the native population in relation to the exploitation of such resources serves to impress one with the fact that the taking over and administration by the Dominion Government of the fur trade of the Northwest Territories would be most desirable from all points of view. The following proposal is therefore made. The Dominion Government should take over the entire control and exploitation of the fur trade and wild life resources of the Northwest Territories by enacting the necessary legislation. This would involve the purchase of such rights as the Hudson's Bay Company have in the Northwest Territories. In order to administer the monopoly it would be necessary to establish certain government posts such as those now maintained by the Hudson's Bay Company. This would be a great advantage in securing proper and adequate government administration in the Northwest Territories, where the need of Government agents to take charge of the affairs of the Indians, the enforcement of the law, the collection of customs and oversight of other government activities in these territories is becoming increasingly felt, and will undoubtedly become greater with their development. . . .

"If such a policy were adopted it would accomplish the following ends: A source of revenue would be created of no small value, even after the expenses of administration were paid, and it is proper that the profits accruing from the exploitation of the fur resources of these territories should go into the national exchequer. It would be the most effective method of conserving the fur resources and

wild life of the Northwest Territories, as the enforcement of the law and the adoption of any necessary restrictive measures could be directly supervised. It would afford a means of attending to the requirements of the natives who stand in need of more immediate supervision, which is difficult to give at the present time. The natives, both Indian and Eskimo, would be protected to a greater degree than at present from the influence and exploitation of unscrupulous traders which would be an advantage from the standpoint of morals and health.

"The nationalization of such natural resources as forests has proved in Europe to be the most successful means of conserving such resources, and at the same time this policy has furnished a valuable source of national revenue. There is no good reason why such a policy should not be adopted in the case of our northern fur resources. The thoughtful consideration of this purpose is therefore respectfully urged."

Another aspect of fur production, which is receiving more and more attention, is "fur ranching" or "fur farming," that is, breeding fur animals under confinement in order to produce fur pelts, and for breeding stock for the market (cf. Jones, '14). The more intensive methods have been applied with varying degrees of success to mink, skunk, marten, silver and Arctic fox, raccoon, otter, fisher, muskrat and beaver. A rather extensive literature has developed dealing with the subject, and it now includes several trade magazines largely devoted to foxes. At present intensive methods modeled after domestication systems are receiving the greatest attention. These methods, however, probably will not solve the most important questions involved in this problem of wild fur production, because millions of acres of waste lands, swamps and forests, will have to be handled for an indefinite period on the "preserve" method, with the animals running wild. It is probable that some valuable fur animals can never be cultivated satisfactorily in captivity, although they may thrive by the preserve method. Such a system has been used in the Algonquin Provincial Park, Ontario, Canada, and of course in our National Parks in the West, particularly in the Yellowstone National Park. Here they have been cared for by the preserve method in great numbers. As has been pointed out, these preserve methods are particularly applicable to large forest areas, especially to those of remote and mountainous areas.

A certain amount of wild stock may be absolutely necessary in the future to maintain the vigor of the captive stock, at least for an indefinite period. One of the most successful silver fox breeders



Plate 21. The muskrat, the leading fur-bearer, in the Montezuma Swamp of Central New York.
Drawing by Edmund J. Sawyer

in Canada, Mr. Johann Beetz ('14) has advocated a National Park in Quebec, in order to preserve the most valuable wild breeding stock of silver fox. This same general idea of preserving breeding stock has been one of the influences in the preservation of the wild life on our National Parks; and it applies specifically to the future needs of fur animals, as well as to game and other kinds of wild life, although it should be clearly understood that only the natural surplus should be used from the Parks for stocking other areas. Methods of increasing fur production are thus seen to involve the development of a special technique for the protection, propagation and management of fur-bearing animals, as well as a satisfactory system of harvesting the fur crop produced, upon both private and public lands.

The data given in the preceding pages, on the annual catch or kill of fur-bearers, are of course only a very rough measure of the annual production of fur. During certain years too many animals have been killed, and inroads have been made on the breeding stock, and therefore the catch is not a true measure of the annual production or increase. Furthermore, great numbers of animals are killed whose pelts are not preserved, so it seems reasonable to consider that all these figures are, in the long run, under-estimates of annual production, except of course when there is evidently a depletion of the breeding stock.

From the standpoint of forestry, the production of a crop of fur would become a phase of forest management, just as the production of forage, timber, fish or game. This will ultimately lead to the application of the principles of conservation to the fur problem. In the National Forests of Colorado more attention has been given to the beaver, as shown by Riley ('21, 21a), and Rose ('23), than to other fur-bearers, but now that a start has been made this kind of work should be expanded rapidly. Adequate provision should soon be made for research on these animals, because there are many new problems arising that can not be solved without careful study by men of technical training. Investigations which Warren ('22, 26, 26a) made for the Roosevelt Wild Life Station on beaver in Estes Park, Colorado, and Yellowstone National Park, and Johnson ('22) of Adirondack beaver, and of New York muskrats ('25) are examples of the kind of studies needed, and similar detailed studies should be made of other species and expanded to cover all aspects of the subject.

FINANCIAL RETURNS FROM FOREST ANIMALS

The Present Deficit. It is a common impression, even among foresters, that animal life in the woods is not only of slight value but is a sort of necessary evil. (For an extreme example, see Gaskill, '18, pp. 17-18.) At the same time these foresters are making strenuous efforts to solve the financial problems of the forest without utilizing fully the important support that may be derived from animals. Several National policies for forestry have been suggested, and plans have been formulated to solve the forest taxation problems (see *Jour. of Forestry*, Vol. 23, Nos. 9-10, 1925), but none that I have seen have been made or have even clearly suggested an adequate recognition of the annual income which it is possible to derive from animals as an important factor in the problem. That is, to use all suitable plant and animal crops from the land. All of the proposed plans and policies have been made solely or almost solely on the basis of the timber crop and have ignored or slighted the wild life, recreation, and even the grazing aspects of the problem.

It will probably be surprising to many foresters, and to the general public as well, to know that today, animals, wild and domestic, living largely in the forests, are paying much toward the annual maintenance of conservation, not only for the animals but also to an important degree for the forest trees. That is, these lands are producing annual animal crops which are producing a revenue which is equivalent to a contribution to the cost of conservation. As very little attention has been called to this fact, it is now quite opportune to see this in its full significance and to recognize all that this implies.

There has been a marked tendency for the standard text books on forestry to treat of animals mainly as a phase of "forest protection," and for this reason discussions of methods of preventing injury are given primary attention. At the same time they generally overlook the fact that forest animals are producing a large part of the revenue necessary to pay for this "forest protection." That animals may be a valuable source of income is, of course, recognized slightly, but it is not, as a rule, as clearly recognized that there is also the productive aspect of the animal problem, and that it must be considered in a manner similar to that of timber production. The production of an income from the animal crop is, equally with that of the wood crop, a part of the general problem of forest production.

A slowly maturing crop like a forest has many financial difficulties because of the delayed harvest and revenue. This is a draw-

back for individual owners, states and nations, but naturally it is more keenly felt by individuals. If, however, *annual animal crops* can be produced and harvested, which will ameliorate the delayed returns, the chances of "protecting," perpetuating and properly utilizing such a forest are greatly increased. The natural increase of the animals produces an annual crop that should be harvested each year, and when fully harvested, and the breeding stock properly cared for, the raw materials for a permanent industry are thus established and are stabilized. The necessity of harvesting the crop is a need easily appreciated by sportsmen and foresters, but it has not been as clearly appreciated by many others. The need also of harvesting the natural increase of animals is never questioned with regard to the grazing animals in the forest, just as it is not on a farm. The farmer who breeds hogs, cattle and sheep to keep and not to harvest and use, does not survive as a farmer. The harvesting of the crop of deer and other large game has also been more generally appreciated by the public, but with regard to fish, other than for sport, there has not been this same general understanding. Why it is that there has been such a backward appreciation is probably in part due to the difficulty of making direct observations on aquatic animals. It is, therefore, more difficult to learn the status of an animal crop in the water. There are many reasons why large numbers of fully mature fish should not be allowed to remain in the waters, after their prime is reached, because they become a drag on the productivity of the waters, as definitely as would predacious fish. In general it is, economically considered, an expensive and short-sighted policy to keep them, mainly to gratify the pleasure of a very few persons who are eager to get large-size record specimens. As Alvord and Burdick ('15, p. 71) have well said: "It is, however, held by those in position to know, that the taking of mature fish is beneficial to the fish yield and that there is probably no better means of securing the fishes of proper size than to seine or net them. It is undoubtedly true that the maximum yield will be secured by taking the fish immediately upon a reasonable maturity for much the same reason that beef animals are slaughtered at the age of two or three years, for like the farm food animals, the fishes mature most rapidly in early life, after which the gain in weight is small in proportion to the food consumed. Therefore, waters must be well fished to produce the maximum yield."

Another of the greatest hindrances in the practice of general forestry is due to the lack of unified control over the forest region, including all the crops, plant and animal. Forestry, in its tardy

recognition (after fish and game administration has been roughly organized), has seldom been given rational control over all of its own crops. The forest area should be handled as a unit, just as a farm is, a condition which may be secured by unifying or coordinating all the interests of the forest, including forage, water, fur, fish and game. With divided authority there must be duplication and waste, as well as conflicting interests. Until foresters see this, come to believe in it, and work for it, we cannot expect much progress from within, and external economic and social pressure may be necessary to accomplish it. We have in this case one of the strongest arguments for State conservation commissions, and for complete Federal control over all National Forests, Preserves, and National Parks. When once executive unity is established there will be *financial and administrative unity*, and a saner management will become possible. This form of organization will then be in a position to harmonize to the best degree all phases of conservation. Today, fire protection and land purchases are often considered solely a timber problem, and yet a fair part of the expenses should be charged to the production of fish and game, and recreation, because everyone should know that forest fires are deadly enemies of all forest animals, and that public preserves are needed to secure adequate protection of wild life.

Because food and game animals cannot be sharply separated it is often impossible to separate their financial statistics, as they are usually published. The following fragmentary evidence, however, is complete enough to make sure the point that today in New York State the annual animal crops, taken primarily from the forest lands, are the most important single source of income for the practice, not only of forestry (including fire protection of both trees and wild life), but as well for conservation in general. I will give first, as an example, evidence from the State of New York, which does not harvest its tree crop in its State Adirondack and Catskill Forest Parks, and therefore receives no direct income from that source, and then consider other regions. In the Allegany State Park, however, provision is made for a commercial forest in this Park.

As a measure of the physical resources of New York State, the following Table No. 8 has been prepared (U. S. Census Abstract, N. Y., Supplement 1910; Pettis, '15; Rosenbluth and Paul, '17; etc.).

TABLE NO. 8—SHOWING APPROXIMATE RELATIVE AREAS OF LAND, WATER AND FORESTS IN NEW YORK STATE.

CHARACTER OF AREA	Square miles	Acres
Gross area of New York State (U. S. Census, 1921, pp. 664, 687) . . .	49,204	31,490,560
Land area (U. S. Census)	47,654	30,498,560
Forest area, about 37% of land area (Rosenbluth and Paul '17, p. 6) . .	18,590	12,000,000
Agricultural area, improved (U. S. Census)	23,412	14,884,039
Water area, not including the ocean or Great Lakes (Census, p. 28) . .	1,550	992,000
Forest and (fresh) water area, exclusive of Great Lakes	20,140	12,992,000
Total area of Adirondack Forest Preserve (Pettis '15, p. 12)	2,671.8	1,710,015.7
Water area in same	368.7	235,994.9
Total area Catskill Forest Preserve	174.3	111,598.6
Water area in same . . . . .	.19	123.5
Total area of Catskill and Adirondack Preserves	2,846.2	1,821,614.3

In reply to my inquiry the following information was received from F. G. Ray, Assistant Engineer in charge of the U. S. Lake Survey Office, Detroit, Michigan:

"1. In reply to inquiry in your letter of October 28, 1918, regarding water areas of states bordering on the Great Lakes, there is furnished the following tabulation of water areas in square miles on the Great Lakes and connecting waters between the International Boundary and the American shore line:

	sq. mi.
Lake Superior	20,686
St. Mary's River	145
Lake Michigan	22,404
Lake Huron	8,900
North Channel (Lake Huron)	91
St. Clair River	10
Lake St. Clair	169
Detroit River	18
Lake Erie	4,974
Niagara River	14
Lake Ontario	3,470
St. Lawrence River	94
[Areas in rivers	281
Total acres in lakes	60,694]

"2. Inasmuch as the boundary lines of the States are not definitely fixed by statute or survey, it is impossible to give these areas with relation to the states." However, Gannett (Bull. U. S. Geol. Surv., No. 302, p. 8, 1906) gives for New York, approximately 3,140 square miles of Lakes Ontario and Erie.

Table No. 8 shows that in New York State, in round numbers, there are 32,000,000 acres of which about 12,000,000 are forest, and nearly 1,000,000 acres of fresh water, not counting the area of the Great Lakes. If we add to this water area that of Lakes Erie and Ontario, of approximately 2,009,600 acres, there is a total of over 3,000,000 acres of fresh water. This makes a total of about 15,000,000 acres of non-agricultural lands and inland fresh water for the state of New York.

What income is and can be derived from this great non-agricultural area in New York? First of all, as has been said, there has been a lack of confidence as to the best method of managing the cutting of timber in the State Forest Parks, and for that reason it has been prohibited by the State Constitution. This results in a reduced income, which has possibly retarded the economic and social development of these areas, although the whole area would probably have been lumbered off and burned before a proper administrative system was devised, and then the region would have been both damaged and desolate. For the present the income from timber, and from leasing camp sites, is eliminated, and the only other sources of revenue, for protecting and managing these areas, is by direct taxation, from the annual income from wild life privileges in its various forms, and small amounts from miscellaneous sources. An angling license has been needed, as it would be an important and legitimate source of income for conservation, but this was only provided for in 1926.

It is well to recall, at this point, just what is meant by *income* from such forest regions, viewed as productive areas. There is first of all the revenue that may be derived from the periodical cutting of the forest, at intervals, say of 30 to 50 years. With the large acreage involved, in a managed forest there would be cutting under way, somewhere, all the time, thus giving the sustained yield needed for permanent wood-using industries. Then there are also the annual crops to be derived from fish, game, fur, and under certain conditions from grazing. All of these annual crops may be made to produce income in various ways. There is the capture and sale, or some other form of utilization of the fish, game, fur and forage, all of which may produce a direct income; or these animal resources may, with climate, forests and scenery, attract great numbers of visitors who come into the region and live there for a time, spending large sums of money directly or in making permanent improvements and settlements, and thus greatly increasing all eco-

conomic values in the region. The sources of income may thus be numerous, including the sale of the plant and animal crops, and in addition the licenses, fees and fines derived from hunting, fishing, and finally the increased land values, the payment of more taxes, and the improvement of roads and other public benefits, which are made possible by the larger population. These are largely general conditions which, with local modifications, apply also to other forest regions.

The New York State Conservation Commission has kindly furnished the statistics of its income and expenditures for the period of 1914-1924, as given in Tables 9 and 10. The receipts of the Commission from wild life, including the rentals of the marine shellfish lands, also include a number of minor items which are too small in the aggregate to influence the general results and therefore they are considered as a whole. It should be borne in mind at the start that all this revenue is not derived from forest lands as, of course, there is a considerable item of wild life which cannot be accurately determined and which is derived from the tilled lands. But, speaking in general terms, it seems safe to say that, on the whole, the great bulk of these wild life revenues, fish, game and fur, come from the non-agricultural lands. It is a resource which the landowner does not own, as wild life belongs to the State and the Nation.

Attention is called to the large revenue derived from the hunting licenses, producing in 1924, \$365,776; the tagging of game, \$13,574; the tax and rentals of shellfish marine lands, \$17,047; fines and penalties producing \$88,170; and a total of all receipts from fish and game of \$521,260. The total receipts of the Commission were \$572,899, of which all but \$51,638 came from fish and game. Thus the fish and game receipts were 90.9% of the total receipts of the Commission (except Saratoga Springs funds). The per cent for 1923 is the lowest recorded since 1914 when the fish and game receipts were 90.7% of the total receipts of the Commission. Let us turn to the expenditures. The general administrative expenditures amounted in 1924 to \$111,555. The Division of Fish and Game cost \$641,493 (or in excess of income \$120,233) and the Division of Lands and Forests cost \$513,786.21, exclusive of capital expenditures for the purchase of land. This great cost is due to the extensive purchases of land which the state has had under way, and for their "protection." The total expenditures, aside from land purchase, which is an addition to capital, was \$1,266,834.85, and the

total receipts were \$572,899, making a maintenance *deficit* of \$693,935.33, which is provided for by a legislative appropriation.

Thus, without a resident angling license (during the interval covered by the table), and with a nominal hunting and trapping license, and without allowing for the products of the State hatcheries and game bird farms, there is a deficit of \$693,935.33 in 1924. Without question an angling license would produce an average between \$200,000 and \$300,000, or possibly more each year. It thus seems that the State could easily derive a million dollars revenue per year from wild life. In these estimates of income no credit is given for the production of fish from the hatcheries, or game from the game farms which, at commercial rates, would make a very considerable item. For the year 1919-20 the Commission calculated that these were worth over \$300,000. The same is true of the trees produced at the State nurseries. It would probably be wise to require a distinct license for hunting deer, separate from the general hunting license, and make it a reasonably high price because the deer really cost the State much to produce them.

These statistics show that there is the greatest apparent deficit in the case of the Division of Lands and Forests and that this is due to several factors. First of all, this involves the expense of land purchases, fires and other protection, the State nurseries which produce trees for the whole State, and not merely for the State lands, and because of two prohibitions—an adequate system of leasing camp sites, and the Constitutional mandate against the cutting of the timber. The cost of land purchase should not, as has been said, be looked upon solely as a timber expense.

These statistics bring out clearly that in New York State wild life has produced, *even with only very partial use of potential revenues*, an income from over \$300,000 to over \$700,000 annually, without making allowance for the products of the hatcheries and the game farms. It is probably a safe estimate to say that wild life today is much more than paying for itself, even without using all available revenue. It is decidedly nearer being self-supporting than timber production is, even previous to 1925 when there has been no angling license.

In Ontario the Game and Fisheries Department for 1921-22 received in revenue \$736,519, and spent \$347,352, giving a surplus of \$389,167, equaling nearly 53% of the revenue. This does not include the products of the hatcheries, or of course the fish and game harvested by the public. For the same period the Lands and Forests revenue was \$4,035,747, and the disbursements were \$2,029,-

453, of which the timber produced \$3,698,267. In this case the government is not spending huge sums to purchase the land, and the forests are already productive of timber, so that there is a large annual income from this source.

In order to make a general comparison with the adjacent State of Pennsylvania, I secured through the courtesy of Mr. N. R. Buller, Commissioner of Fisheries, Mr. Seth Gordon, Executive Secretary of the Board of Game Commissioners, and Mr. J. S. Illick, Chief of the Bureau of Information of the Department of Forests and Waters, the following incomplete records. Mr. Buller gives the following concerning the fish:

"Statement showing amount of money appropriated to the Board of Fish Commissioners in the General Appropriation Bills by the Legislature of 1913 to 1921, inclusive; also receipts from the Resident Fisherman's License for 1922-1923.

Appropriations

<i>Year</i>	<i>Amount</i>
1913.....	\$272,850
1915.....	247,000
1917.....	308,100
1919.....	298,400
1921.....	138,900

Receipts from License

1922.....	\$207,425	53
1923.....	219,088	44

"These appropriations were all for a period of two years, with the exception of 1921. This appropriation was made to carry the Board over until the Resident Fisherman's License became effective, which was January 1st, 1922.

"This Board also has what is known as the *Fish Propagation Fund*, which covers receipts from fines, commercial hatcheries, seine licenses, non-resident licenses, Lake Erie licenses, etc. During the year ending December 1, 1922, we received \$22,011.96 and the year 1923, \$30,909.19."

The game situation is thus stated by Mr. Gordon: "The resident hunter's license law was passed by the Pennsylvania Legislature on April 17, 1913. The revenue received from the sale of these licenses was not available for the use of the Game Commission until

June 1, 1915. Our income from licenses and fines for the past ten years has been as follows:

<i>Year</i>	<i>Amount</i>
1913.....	\$282,818 77
1914.....	281,821 91
1915.....	261,320 59
1916.....	285,390 77
1917.....	306,906 45
1918.....	335,455 05
1919.....	418,508 93
1920.....	460,334 12
1921.....	503,204 74
1922.....	506,959 36
1923.....	622,150 33

"In 1913 the Game Commission received an appropriation from the General Revenue of the Commonwealth in the amount of \$97,400 to carry on our work for two years or until June 1, 1915. Our expenses for the two fiscal years from December 1, 1914 to November 30, 1916 amounted to \$329,736.57. Our *total expenditures* for each fiscal year since that period has been as follows:

<i>Year</i>	<i>Amount</i>
1917.....	\$261,757 57
1918.....	245,439 89
1919.....	328,809 05
1920.....	544,069 46
1921.....	655,351 91
1922.....	539,176 78
1923.....	511,751 41"

The forest condition is thus presented by Mr. Illick:

"I take pleasure in giving you some information about the cost of maintenance of the State Forests and the income derived from them. The appropriations for forestry during the last 12 years have been as follows:

<i>Biennium</i>	<i>Amount of Appropriation</i>
1913-15.....	\$664,438 94
1915-17.....	630,750 00
1917-19.....	807,000 00
1919-21.....	1,071,700 00

<i>Biennium</i>	<i>Amount of Appropriation</i>
1921-23.....	1,870,000 00
1923-25.....	1,315,000 00
<hr/>	
Total.....	\$6,358,888 94

"The appropriations to the Department of Forestry prior to 1913 aggregated \$4,076,115.61. This makes a grand total of appropriations of \$10,435,004.55. It is significant to know that not all of this money was expended on the State Forests, since the protection of the forests by this Department is State-wide, and a considerable amount has also been spent for the growing and distribution of forest tree seedlings, and also for the examination of privately owned timberland.

"The receipts from the State Forests since 1913 are shown in the following table:

<i>Calendar Year</i>	<i>Amount</i>
1913	\$13,076 07
1914	15,066 64
1915	13,483 84
1916	21,459 97
1917	21,569 69
1918	24,410 24
1919	34,517 15
1920	50,633 80
1921	50,064 51
1922	57,502 89
1923	113,094 34
<hr/>	
Total	\$414,879 14

"The total receipts to January 1, 1924, amounted to \$477,936.75, of which \$63,057.61 was secured from the State Forests prior to 1913.

"The State now (January 1, 1924) owns 1,131,276 acres of forest land purchased at a total cost of \$2,559,239.73. This shows an average purchase price of \$2.26 per acre.

"In connection with our forest bond work we have given considerable attention to working out the actual maintenance charge per

acre for the State Forests of Pennsylvania, and also estimated the probable future cost of maintenance. The following table gives the preliminary results of our work:"

	1921	1971	Average (1921-1946)	Average (1921-1971)
Improvements.....	\$11	\$15	\$13	\$14
Administration.....	17	40	23	34
Protection.....	8	5	7	6
Taxes.....	5	5	5	5
Total.....	\$41	\$65	\$48	\$59

An examination of the foregoing facts, on the income and expenditures of conservation in Pennsylvania, shows several points of considerable interest. The value of a resident fishing license, as a source of revenue is shown to exceed that of the income previously available from fishery appropriations. With regard to the game the income from licenses and fines for 1917 was \$306,906 and the total expenditures for the same year was \$261,757, thus showing a balance of \$45,149. In 1920, 1921 and 1922 the expenditures exceeded this income and in 1923 the income again exceeded the expenditures by \$110,399. The expenditures, however, from 1917 to 1923 were \$67,162.91 less than the income, so that the work is more than self-supporting.

The forests show a large expenditure in purchasing land, and at a very low rate per acre, and a very small income derived from these lands, which are mainly cut over or burned. Here again we see the land acquisition is largely in the hands of the Department of Forests (and Waters), and fire protection is also conducted by them. These statistics show, as in New York State, that a very large annual revenue, amounting to hundreds of thousands of dollars, is now derived from fish and game, and in both cases under a system of only nominal license fees. No allowance has been made in these calculations for the products of the hatcheries, game preserves, or the nurseries. An outstanding conclusion, as in New York State, is the relatively large annual revenue derived from wild life and the relatively small revenue from the timber. In New York State considerable areas of the forest are virgin but in Pennsylvania they are cut over or burned, so that it will be a long period before the timber crop can be very productive. It is during this period that annual income is most needed.

Let us turn to the Canadian National Forests and examine their financial status. The Canadian Forestry Branch has kindly furnished

TABLE NO. 11 — SHOWING INCOME AND EXPENDITURE OF CANADIAN NATIONAL FORESTS

FISCAL YEAR	Grazing income	Timber income	Special uses income	Total income	Total expenditure	Grazing income per cent of total income	Grazing income per cent of total expenditures	Timber income per cent of total income (average)	Timber income per cent of total expenditures (average)
1912.....	\$92 75	\$21,036 69	\$940 56	\$22,070 00	\$213,351 86	0.42	.04	95.3	9.8
1913.....	220 00	18,867 21	2,575 38	21,663 40	335,734 24	1.0	.06	87.0	5.6
1914.....	6,060 57	27,306 69	3,059 14	36,426 40	376,241 20	16.6	1.6	74.9	7.2
1915.....	5,656 54	23,569 77	3,287 58	32,513 89	428,331 01	17.3	1.3	72.4	5.5
1916.....	7,172 23	28,374 19	4,467 04	40,013 46	424,571 47	17.9	1.6	70.9	6.6
1917.....	8,700 62	41,909 24	4,752 25	55,368 16	338,039 34	15.7	2.5	75.0	12.3
1918.....	23,803 78	49,406 40	6,939 74	80,149 98	351,890 10	29.7	6.7	61.6	14.0
1919.....	42,247 79	70,229 85	13,193 10	125,670 74	493,095 12	33.6	8.7	55.9	14.2
1920.....	44,590 63	79,884 06	17,618 63	142,093 32	515,221 16	31.3	8.6	56.2	15.5
1921.....	42,724 37	91,299 08	10,239 30	144,263 65	595,956 39	29.6	7.1	63.2	15.3
1922.....	39,628 32	91,517 28	10,670 92	141,816 52	588,235 28	27.9	6.7	64.5	15.5
Total.....	\$220,904 55	\$543,401 42	\$77,743 64	\$842,049 61	\$4,660,668 07	26.2 %	4.7 %	64.5%	11.6%

TABLE NO. 12 — SHOWING INCOME AND EXPENDITURES OF U. S. NATIONAL FORESTS

FISCAL YEAR	Grazing income	Timber income	Special uses income	Total income	Total expenditure	Grazing income, per cent of total income	Grazing income, per cent of total expenditures	Timber income, per cent of total income	Timber income, per cent of total expenditures
1912.....	\$968,842 26	\$1,089,702 04	\$98,812 27	\$2,157,356 57	\$5,530,210 56	44.9	17.5	50.5	17.0
1913.....	1,007,739 51	1,341,337 03	118,512 93	2,467,590 07	5,348,325 81	40.8	18.8	54.3	25.0
1914.....	1,002,347 59	1,319,425 72	115,930 90	2,437,710 21	5,735,127 73	41.1	17.5	53.7	23.0
1915.....	1,130,495 00	1,183,966 59	167,007 76	2,481,469 35	6,239,920 47	45.6	18.1	47.7	18.9
1916.....	1,210,214 59	1,426,994 50	186,331 62	2,823,540 71	5,952,225 64	42.9	20.3	50.5	25.6
1917.....	1,549,794 76	1,692,515 21	214,718 44	3,457,028 41	6,038,109 17	44.8	25.7	48.9	28.0
1918.....	1,725,821 94	1,633,640 42	215,458 71	3,574,930 07	6,770,955 00	48.3	25.4	45.7	24.1
1919.....	2,609,169 85	1,540,099 06	209,145 05	4,358,414 86	6,767,151 00	59.9	38.5	35.3	22.7
1920.....	2,486,040 20	2,007,395 51	240,040 54	4,793,482 28	9,730,248 00	51.9	25.5	43.1	21.2
1921.....	2,132,074 99	1,775,901 08	243,955 35	4,151,931 42	7,938,209 00	51.4	26.7	42.7	22.3
1922*.....	1,315,975 40	1,828,191 64	277,364 18	3,421,531 22	8,042,427 00	38.5	16.3	53.4	21.4
1923.....	2,341,485 85	2,721,876 20	272,450 08	5,335,818 13	7,870,402 00	43.9	29.7	51.0	35.8
Total.....	\$19,480,601 94			\$41,460,803 30 = 47% for 12-year period.					

* See page 10, Forester's Report for 1922, to explain this drop.

me with the data presented in Table No. 11, showing the income from the National Forests and the expenditures for the decade 1912-'22. This table shows that the total average income was \$842,000, and the total annual expenditure \$4,660,600. The timber income average is 11.6 per cent of the total expenditures, and the timber income is 64.5 per cent of the total income. The grazing income is 4.7 per cent of the total expenditures and 26.2 per cent of the total income. Thus the grazing produces about one-fourth of the income and the timber less than three-fourths, or 65 per cent. These forests are therefore not self-supporting, as the annual deficit shows, and there is no income credited from fish, game or fur.

A similar tabulation was kindly furnished me by Mr. Will C. Barnes, Assistant Forester, U. S. Forest Service, and is given in Table No. 12. This shows that the timber income for 1923 is 35.8 per cent of the total expenditure, and of the total income it is 51 per cent. The grazing income for 1923 is 29.7 per cent of the total expenditure, and 43.9 per cent of the total income. *For the 12-year period tabulated the grazing income was 47 per cent of the total income.* These figures show that today about 25 per cent of the income from the Canadian National Forests is derived from grazing, and nearly 50 per cent of our income from our National Forests is derived from grazing. This much revenue is secured even without charging full value for the forage and when, as will be shown later, a full charge is made, the income will be increased greatly. These facts show that the annual sale of forage sold for utilization by domestic grazing animals is the greatest single source of revenue from our National Forests, and we should realize that this is derived from animals rather than from trees.

With regard to the higher grazing fees, Mr. Will C. Barnes writes under date of May 15, 1923: "On the first of January, 1925, unless Congress interferes in the meantime, we propose to put into effect a set of grazing fees based on the commercial value of the forage on the National Forests, which will undoubtedly more than double the present income from grazing, making the annual income from this source between 4 and 5 million dollars, depending on the demand for range. Congress is not likely to intervene because we have undertaken this revision of the grazing fees at the express command of that body. Even with this increase we feel that the fees will be somewhat lower than the stockmen are willingly paying for grazing on like areas in private ownership."

Again Mr. Barnes writes, November 14, 1923, as follows: "Colonel Greeley has determined that beginning with 1925 the charge

for grazing livestock on the National Forests will be based upon the appraised value of the range when compared with like ranges in private ownership, such as State lands, Indian Reservations, or private holdings, which are fairly comparable in carrying capacity, topography, and other points with our National Forest ranges. This really means the commercial value of the range. The stockmen object, of course, to this basis for determining the fees, claiming that as it is national land the government should furnish the range at a rate which will return to it about the actual cost of administration plus some slight increase to reimburse the government for the use of the land. This would result in cutting our receipts from grazing fees, as low as they are, almost in two. If a permit could be granted to every western stockman to graze his animals on national forest ranges this idea might be sound. The fact is, however, that we are able to take care of but about 18 per cent of the cattle and 32 per cent of the sheep in the eleven western range states, which means that those stockmen who can obtain permits would have a decided advantage over the rest who cannot, for they would be securing cheap feed and using a National resource at the expense of the whole people.

"Our range appraisal figures which are now being worked up after two years investigation will show the character of each large range unit, its topographic drawbacks, the value of the forage on it, whether or not the watering facilities are above or below the average, etc. Such figures as these will give us an excellent basis for establishing the fees on their commercial value."

When discussing the deficit of the Forest Service attention was called to the fact that grazing was one of the most important sources of annual income from the National Forests. On account of the fuller data already presented this aspect will not be elaborated here. The average income for the last 6 years (1918-1923) is seen to be \$2,101,761 (see Table No. 12). Furthermore, when grazing fees are equivalent to the *full value* of the forage the prospects are that they will make up the present maintenance deficit, and make the Forest Service a self-sustaining organization.

Elsewhere attention has been called to the reindeer of Alaska as a part of the grazing problem so that in this connection the income which has been derived from them should be recalled for their possible relation to financing conservation policies there. Alaska reindeer (U. S. Bureau Education Bull. 1918, No. 5, p. 14) owned by the natives in 1917, at \$25 per head, had a value of \$1,686,200 and produced an income to the natives between 1913 and 1917 of \$568,352,

and other owners derived \$214,443 from them. The total valuation and income amounted to \$3,247,345 for which the Federal Government appropriated in all \$317,000 and gained \$2,930,345, or 924 per cent on the project, and this does not include \$54,000 worth of reindeer which were sold to a private firm. As startling as these figures are they have not yet attracted much public attention or aroused the public to a realization of what should be done for the arctic grazing problem. If caribou instead of reindeer should prove to be more suitable for Alaska, this would remain a wild life problem, but if the reindeer proved to be the most valuable they might then be made an essential part of a proposed Federal grazing service, which should include the arctic prairies as well as the arid ones. The success of the reindeer in Alaska is no longer an experiment, it is an established industry. Jackson ('05, p. 1110) states that in Lapland the reindeer are taxed by the Government \$1 per head and yield an annual revenue of \$400,000. There is thus an abundance of evidence to show that reindeer (and possibly the same may be true of caribou) may be made the source of much revenue in the Far North.

In concluding this discussion of the potential financial returns from the forest animals it is well to call attention to the fact that as the agricultural lands are cultivated more intensively there will be an increasing demand for all food animals, and when this is reinforced by the recreational demand for game and fish it is natural that there will be a tendency for vast areas to become depleted, because the demand will far exceed the supply. We need occasionally to recall how much our historical development influenced our present condition. In the pioneer days timber was free, it was even an incumbrance to agriculture, and only rather recently has its price become high, but ultimately this will tend to approach the price required to produce it. Grazing was once free in the West; later a small fee was required for the lands included in National Forests, and even there its full value was not charged for many years. This price is destined to increase. Fish and game were once also free to all, and we are now just beginning to realize that the fees paid in taxes and licenses are in reality only a trifling "admission" fee. These prices must increase, and ultimately fishermen, anglers, trappers, and hunters may find it necessary to pay a price at least equivalent to what it costs to produce the crop, in order to share in the harvest. In the past the license system has been conducted more like the ticket system of admission to the moving picture show, rather than admission to a business establishment. We do not sell

tickets to butcher shops or grocery stores; there we pay for what we get. Sooner or later we may find it necessary to come to this in the handling of our fish, game, fur, grazing, and other similar natural resources. This may be the main economic foundation upon which these food and wild animals can be permanently maintained. The demand for most of these animals is a permanent and sustained one, and at present in marked contrast with that for inaccessible timber. Speaking of the demand for big game Leopold ('18, p. 407) contrasts this with that for timber as follows: "American foresters . . . have preached the principles of silviculture, notably sustained yield, but have as yet been unable to practice them. How then, could they have practiced them with game? . . . *Because of lack of a demand* for inferior grades and remote stumpage. Because of our old bugbear—inaccessibility. Does game management labor under the same handicap? Emphatically it does not. *There is a demand for every head of killable big game in the United States*, wherever it may be. . . . Indeed, it may be said that, as far as a market is concerned, we are more ready to practice game management than to practice forest management." This demand is a consideration which should not be overlooked. All wild life, to be sure, does not meet with this demand, but much of it does.

Income from the Resort Industry and Wild Life. In the preceding section emphasis was placed upon the fact that wild animals were one of the main sources of funds for conservation in New York, as grazing animals are in the income of the National Forests. In this discussion attention was also called to the large numbers of fish, game, fur and food animals which forests produce, but no emphasis was put upon the income which could be derived from the sale or other use of such animal crops. We are now ready to consider what is being and can be derived financially, and directly or indirectly from forest animals.

The detailed source of all this income can not be determined accurately, in many cases, and such cases will be considered first, and later those dealing exclusively with animals. The Maine Commissioners of Inland Fisheries and Game, in their Annual Report for 1902 (p. 22) state, that: "It is practically impossible to distinguish between the game interests, the inland fishing interests and the recreation or vacationist's interest." They further say (pp. 19-20): "As careful a census as we were able to take, employing thoroughly reliable canvassers, shows that more than 133,000 persons have visited Maine this year (1902) to fish, on a vacation, or to hunt from outside of the State. This same canvass shows that



Fig. 177. Mountain lion, Yosemite National Park, California. Photograph by courtesy of A. C. Pillsbury, Yosemite.



Fig. 178. Mountain lion kitten, Yosemite National Park, California. Photograph by courtesy of J. T. Boysen, Yosemite.



Fig. 179. Marten in trap, Uinta National Forest, Utah. Photograph from the U. S. Forest Service.



Fig. 180. Beaver in Yellowstone National Park. Photograph by E. R. Warren.

from six to twelve million dollars were spent by them among our people." ". . . The total value of all farm crops in Maine for the year 1899 was \$21,954,054. Thus it will be seen that the total amount of money spent in Maine this year by non-resident fishermen, summer visitors and hunters is more than 30 per cent of the total value of all farm crops raised in Maine in the year 1899, the last year of which we have any report." These visitors furnished a large part of the market for this farm produce, so that directly and indirectly, the income from them is much greater than 30 per cent. The Maine Bureau of Industrial and Labor Statistics has made a special census of the summer resort business in the State (23d. Ann. Rep. for 1909) and Commissioner T. J. Lyons reports that (p. 222): "The approximate number of persons coming annually into our State for vacation purposes, given by one of our railroad officials who is in a position that enables him to make a very close estimate, is placed at 400,000. The same authority places, at a very conservative estimate, the average amount paid out by each individual for all expenses at \$50.00. This means \$20,000,000 put in circulation in Maine each year by those who come from other states for rest and recreation, to hunt and fish, to breathe our pure, bracing air and enjoy our magnificent scenery. It represents a sum above the combined value of our entire grain and potato crops, more than the output of all our pulp and paper mills, or of all our lumber mills. It is the business life, the stock in trade, of not a few of our towns, in short, it is our greatest industry." In the Annual Report of the Maine Commissioners of Inland Fisheries and Game for 1904 (pp. 76-77, 1905), they state: "We give below an extract from an address delivered by Hon. F. E. Boothby, general passenger and ticket agent of the Maine Central Railroad, before the Century Club of Bangor during the present month, as showing how the great transportation companies of the State look upon the fish and game interests of Maine. Mr. Boothby said, 'Well now, something is taking place here in Maine as illustrated by the number of passenger trains which are run, and especially so far as the Pullman equipment is concerned, it is acknowledged by the Pullman company that considering the number of cars engaged in service that the run between Boston and Bangor is the best paying one they have. To illustrate, during the month of August, 1904, 34,598 passengers were carried in Pullman cars on the Maine Central Railroad, and the summer resort business is so developed that it is estimated that the number seeking Maine annually is in excess of 300,000, leaving within the borders of the State each year more than \$13,000,000. A feature of summer travel

which is yearly expanding is that of the great increase in numbers of sporting camps for hunting and fishing throughout the State and camps are known where no life is taken and people come there to study the trees, plants, the birds and wild animals, and to enjoy the delightful scenery and pure air which everywhere abounds in Maine'."

Former Senator W. P. Frye (cf. Report Me. Comm. Fish and Game, 1902, p. 21) has said of the stabilizing financial effect of these summer visitors as follows: "In all times of business depressions and distress, financial panics and consequent unemployment of labor, so seriously effecting the country, the State of Maine has suffered much less than any other state in the American Union, mostly, if not entirely, due to the large amount of money left with us by the fisherman, the summer tourist and the fall hunter, the seeker after change, rest and recreation."

The social effects of this summer resort industry are so important that they likewise deserve mention, as Commissioner Lyons ('09, p. 223) has said: "Investigation shows that those places which have a large number of non-resident cottages have longer and better schools, pay their teachers higher wages, maintain larger and better equipped libraries and construct more miles of improved roads than other towns otherwise equal.

"The benefits do not all come in a financial way. The social side has its advantages. Many of our visitors are persons of liberal education and extensive travel, as well as of wealth, and their influence goes to educate, to broaden the minds and increase the self respect of those of our people with whom they come in contact. They contribute liberally to the construction and maintenance of churches and libraries; they often give free lectures and readings and other entertainments of a high literary order, all of which go to raise the standard of intelligent thought and right living, for whenever persons of education and refinement come in contact with those who have been less favored by opportunities the tendency is to awaken a desire for improvement and a determination to make more out of life."

Maine has a gross area of 33,040 square miles, 29,895 of which is land, and 3,145 is water. Of the land area only about 12,000 square miles are in farms, and only 12 per cent of this land is improved. This means that Maine is very largely a forest state. The Department of State Lands and Forestry for 1916 received an appropriation of \$73,952.87, and spent \$61,356.77, leaving a balance. For the same year the receipts, aside from appropriations, of the

Commissioners of Inland Fisheries and Game was \$42,066, of which about \$40,000 was derived from licenses, for activities related to fishing and hunting, although the report does not state that these funds are directly available to the Commissioners. Furthermore there does not appear to be a general angling license, which could be made to produce a considerable additional increase in revenue. These figures indicate that the maintenance of the wild life in the State can readily be made more than self supporting under proper management. These estimates from Maine are rather old, and an up-to-date survey would probably make the case even stronger. A similar survey should be made of the Adirondacks and Catskills in New York.

Avery ('22a, pp. 2-3) gives the following data on the recreational situation in Minnesota: "Briefly, it might be stated here that the recreation traveler is attracted very strongly by opportunity for fishing and shooting—particularly fishing. Forests devoid of animal life and streams and lakes empty of fish are not attractive. The mere knowledge that these living things are present and may occasionally be seen adds tremendously to the incentive of vacationists to visit our delightful northern lake regions and woodlands.

"The American public is acquiring the habit of motor and outing vacations and we are in position to capitalize this fact in a commercial way to a greater extent than we ourselves know. Last year the extent of such travel expressed in figures was as follows:

	Tourist travelers	Value in business
Michigan.....	.....	\$40,000,000
Wisconsin.....	500,000	7,500,000
Minnesota.....	300,000	15,000,000
Total.....	.....	\$62,500,000

"It is evident that the basis of estimate on this item is not uniform in the three states and there is need of collaboration between the various tourists agencies in a uniform method of acquiring these statistics. The figures are given as furnished and are not my own estimate."

A recent investigation by Waugh ('18, pp. 24, 27) of the recreational uses of the National Forests has revealed some startling results. Waugh's studies show that the recreational visitors, seeking fishing, hunting, camping, motoring, etc., in these Forests for the

year 1917, numbered 3,000,000 persons. He states that: "A further estimate made by the forest officers on the ground indicates that the average stay of these visitors was two and one-half days. This gives us a basis for a more accurate measurement of the total recreation product, since students of this subject generally agree that the hour is the proper unit by which to measure recreation. If, then, the average visitor spent two and one-half days on the Forests, and if we call these 10-hour days, thus converting the time per person to 25 hours, and if we multiply this factor by the number of visitors (3,000,000) we reach the considerable total of 75,000,000 recreation hours. While the factors here used are all estimates, they are carefully made upon actual counts, and the final product is not far from the truth.

"The further matter as to the market value of this body of recreation can be determined within reasonable limits. Mr. G. A. Parker, superintendent of parks in Hartford, Conn., the recognized authority on such matters, computes that park recreation as managed in the United States costs on the average 2 cents an hour. This, however, is cost not value.

"The human value of an hour spent in skating in a city park or fishing in a National Forest would be hard to estimate; but ultimate human values are seldom estimated in dollars and cents. Our usual figures indicate merely commercial values, i. e., market prices. Now the commercial value or market price of recreation is determinable quite as easily and exactly as the price of beans or books or tobacco. Enormous quantities of recreation are daily bought and sold in the open market, and the prices are as well recognized as for any commodity of commerce. The movies cost 10 cents or 15 cents; the vaudeville theatres cost 25 cents or 50 cents; the 'legitimate drama' costs 50 cents to \$2 a hearing; concerts cost from 25 cents to \$2; grand opera \$2 to \$5; a baseball game costs 50 cents; the circus costs 50 cents for the big tent, 10 cents for the concert, and 10 cents for the side show.

"A moment's thought will show that 5 cents an hour represents the absolute minimum cost of commercialized recreation. In some towns a person can buy the mild entertainment of an hour's ride on the street cars for a nickel. There still are streets where the movies perform indescribable rubbish for 5 cents.

"On the whole, however, it is perfectly clear that very few and very questionable forms of recreation are offered at the price of 5 cents an hour. If we go up to 10 cents an hour the availabilities improve. The movies are better; we can occasionally get into a

skating rink for a dime; we can buy an hour's reading in a cheap magazine; we can ride out to the park and back; or we can get 10 cents' worth of fishhooks and go fishing. Our choice is still much restricted.

"If we seek a comparison with forms of recreation more nearly like those offered by the Forests, our results are less precise but no less convincing. A few men are able to maintain private hunting and fishing clubs in the Adirondacks, in Maine, or on the Restigouche. The time they pass at these resorts costs them anywhere from \$1 to \$10 an hour. To take a vacation at any public seaside or mountain resort costs from \$2 to \$10 a day.

"These figures, though somewhat sketchy, are a statement of plain facts. In view of them the following generalizations are self-evident:

"1. The minimum market cost to the consumer of wholesome recreation privately provided is 10 cents an hour.

"2. The average cost of commercial recreation is much higher, probably lying somewhere between 25 cents and \$1 an hour.

"It ought to be self-evident, further, that the great bulk of such recreation is worth all it costs. If it isn't, the large majority of our whole population are being daily robbed in their recreation bills. One more premise hardly needs an argument, viz., that the average recreation on the National Forests is as valuable in all human ways as the average of commercial recreations.

"Now if we take even the minimum of these estimates and apply the figures to the problem in hand the results are fairly sobering. For 75,000,000 recreation hours annually yielded by the National Forests (and these figures will be quickly and widely exceeded in years to come), valued at the minimum of 10 cents an hour, amounts to \$7,500,000—a pretty penny.

"Stated in general terms it appears that *the recreation use of the National Forests has a very substantial commercial value, and that recreation stands clearly as one of the major Forest utilities.*"

Since this conservative estimate indicates that the recreational uses of the National Forests amounts to at least \$7,500,000, it must be granted, by every fair-minded person, that fish and game (as well as other wild life) are a very important factor, not only in attracting the public to these forests, but in addition in enlisting their interest in forests, and in appreciating their economic and social value. The amount of wild life enjoyed and secured by these 3 million people is in the aggregate a very considerable amount, which should be credited to forest production.

A thorough survey of the recreational industry of the Adirondacks and Catskills has never been made, but no one will question that these regions function much in the same manner as Maine, the National Forests, and the National Parks. Pratt ('17, p. 5) has said of the Adirondacks: "There are investments of great importance in the Adirondacks that are not investments in timber land. For example, I find that an inventory made in 1903 shows that there were hotel accommodations at that time for 130,000 people; that during that year 451,000 people were accommodated; that 140,000 of them remained for more than two weeks; and that 79,000 came from without the State. There was then invested in these hotel improvements \$16,427,000, exclusive of land. Caring for tourists gave employment to 26,400 people, to whom \$1,130,000 in wages were paid, exclusive of board. The receipts of these numerous places during the season of 1903 were \$8,725,000. In a similar manner, other statistics could be gathered showing investments, employment of labor and receipts in transportation, mercantile and other pursuits incidental to handling the great vacation business of the mountains.

"Statistics of the lumber production of the Adirondack region show that the maximum production was obtained about 1905 and has since been falling off, whereas the vacation business has tremendously increased. Assuming a fair basis for stumpage, this product was valued in 1903 at \$3,275,000 and probably \$5,600,000 were spent in wages in connection with the lumber industry. I regret that there are not available figures to make it possible to carry out any like comparison of all the industries in this region for the same period. I believe, however, that it is fair to assume that if such information were available, it would show conclusively that the lumbering industry amounts to probably not more than 20% of the business of the Adirondacks."

Of course this condition holds in a forest largely belonging to the State in which the cutting of timber is prohibited by law. Under a satisfactory system of management, harmonizing all of the industries and uses of the region, not only would the revenue from timber be increased, but also that of many other industries, particularly those dependent upon wood. At the same time, it would probably give winter and spring employment for the local inhabitants, at a season when the recreational industries are relatively inactive.

A striking comparison, however, has been made along the lines suggested by Waugh, for the Palisades Interstate Park, by Brown ('20, p. 65) as follows: "If we compute the cost of recreation in

the Palisades Interstate Park on the foregoing basis, it will appear that with 52,350 campers spending on an average 8 days each, and averaging their recreational hours at 10 a day, it would be equal to 4,188,000 recreational hours. At 10c an hour we have \$418,800 worth of recreation in the camps alone.

"The 621,024 people who visited Bear Mountain averaged five hours, or the equivalent of 3,105,120 recreational hours. At ten cents an hour this is equivalent to \$310,512. The 458,415 people who spent an average of seven hours in the Palisades Park region during 1918 aggregated 3,208,905 recreational hours, which, at ten cents an hour, is equivalent to \$320,890. Thus we have a total money value of \$1,050,202 for recreation, which the Palisades Interstate Park yielded to its visitors."

Since these calculations were made there has been a great increase in the attendance at the Palisades Interstate Park, where for 1923 the attendance reached even on an incomplete count 5,388,644 for the New York part of the Park, and 1,501,000 for the New Jersey section, and 30,000 campers averaging two weeks each. The Cook County Forest at Chicago with 26,600 acres, is even more extensively visited by its nearby public so that the number of its visitors, between April and November, 1923 reached 7,650,000 and exceeded that of the Palisades Interstate Park. Of course no one can justly claim that all this woodland popularity is based upon wild life, but no informed person will minimize its great importance. The conditions of the forest are those which not only attract the public, but as well are conditions which as a rule are favorable for wild life, and the two interests are mutually advantageous.

In the case of our National Parks the attendance for the season of 1923 reached 1,280,800 visitors, of which 138,300 visited the Yellowstone, the leading wild life park. The only park having an attendance exceeding that of the Yellowstone was Rocky Mountain Park with 218,000 visitors.

In the season of 1921-'22 the Canadian National Parks (Harkin, '23, pp. 7-8) had an attendance of 166,200 people. Of these 65,000 were from foreign countries, and it was estimated that each brought into the country on an average \$300, or a total of \$19,500,000. The total appropriations for the parks for the same period was nearly \$1,000,000. This Harkin estimates meant a per capita cost of \$.12 and brought a return of \$2.22 per capita; certainly a very good investment. Harkin (l. c., p. 9) thus summarizes this recreational industry for Canada: "From reports received from the different sections of Canada, and from railway, steamship, and motor travel

figures, there is good reason to believe that a conservative estimate of the value of tourist traffic into Canada for the past year would total not less than \$100,000,000. This means that it has already become one of our most important sources of wealth. As shown in previous reports when we bring money into the country by tourist travel it is just the same as if we exported goods to that amount and received money in return with this exception that we have sent nothing out of the country that leaves our capital stock diminished. Now compare the value of our four highest exports during the fiscal year 1921-'22 with our export of scenery and they will be seen to rank as follows:

Agricultural and vegetable products.....	\$317,578,963
Wood and paper	179,925,887
Animal products	135,798,720
Foreign tourist travel	100,000,000
Iron and its products	27,312,272

"That means that what we may call our export of scenery must already take fourth place in our foreign trade. It will be observed, too, that its total value amounted to only a little less than one-third of the value of our farm and garden products, while it is considerably more than half the value of our total forest products both raw and manufactured.

"In the twelve months ending March 31, 1922, Canada's total exports amounted to only \$740,240,680, as against \$1,189,163,701 in 1921, and \$1,239,492,098 in 1920. That is a decrease in foreign business of approximately \$450,000,000 in one year. This is an enormous sum but it is less than the annual revenue of France from tourist travel in the years immediately preceding the war, and is approximately equal to the amount formerly spent by Americans in foreign travel each year. If under these circumstances we could attract to Canada a tourist traffic only four times what we are now receiving, it is clear that we should have achieved the same result so far as our national prosperity is concerned. And probably no one would deny that there is no part of Canada which is not capable of attracting four times as many tourists as it had last year. Organized publicity has brought about such results already in special districts. The growth of travel to the Pacific Coast States, as mentioned above, is now eight times what it was five years ago and similar results have been secured in California and other places that have turned their attention to an organized development of the industry. It is reported that at the present time from 30 to 40 per

cent of all the gold in the world is stored in New York vaults. Part of surplus wealth of this kind can be drawn into circulation only through the purchase of luxuries. Now Canada manufactures few luxuries which she can export but she possesses other things that are equally valuable. Her scenery, her romance, her summer, and even her winter climate, her big game and wilderness areas can all be made to serve as a magnet for foreign gold. It is impossible, too, to say to what limits an industry, that caters to a universally desired pleasure, may be developed. Twenty years ago the motor-car was practically unknown. Today over ten billion dollars of private money is invested in cars in the United States alone and the annual upkeep must amount to hundreds of millions. The desire for travel is almost equally universal and in fact it is often one of the reasons behind the desire to own a car."

With such considerations in mind no one can have the slightest doubt of the actual and potential recreational value, from an economic standpoint, of forests, parks, and their wild life. It is solely a problem of intelligent management of this resource, into which wild life already enters to a large degree, even today with its inadequate supervision and appreciation.

Revenue from Wild Life. In the preceding section the income discussed was derived from several resources, and could not be accurately apportioned to wild life and to the other sources. In this part attention will be devoted exclusively to income derived from wild life. Alvord and Burdick ('15, pp. 13, 64) state that along the Illinois River: "Competent local observers estimate that the money spent in the local river communities by sportsmen is fully equal to that derived from the commercial fishery. . . ."

"In the last U. S. Census, which covered the calendar year 1908, the fish taken commercially from the Illinois River totaled 23,896,000 pounds, returning \$721,000 to the fishermen, at about three cents per pound. The river produced 62 per cent of the fish taken in this state, and over 10 per cent of the fresh water fish in the United States."

The experience of Wisconsin is similarly significant. Nevin ('16, pp. 20-21) has estimated that: "All told, residents and non-residents would have taken a total of 3,450,000 pounds of fish from our waters with hook and line. Fresh fish being from 15 to 20 cents a pound on the retail markets. Reduce the price to 10 cents and the total catch would have a value of \$345,000.00. . . ."

"The state spends annually about \$110,000.00 for the protection

and \$50,000.00 for the propagation of fish and game. The total income to Wisconsin from the various sources connected with the hunting and fishing, such as summer resorts, tourists, and the additional taxes paid by the railroad companies because of their great increase in business in the resort regions, may be safely placed at some 5 million dollars a year."

The State contracts for the catching of rough fish, and this for 1915 yielded 138,168 pounds of fish, valued at about \$55,000.00, from which the State derived a revenue of \$11,128.07. By this system the less desirable fish are in part controlled, and an important revenue is derived. For the year 1915-'16 Wisconsin spent \$206,349.00 for its Conservation Commission in caring for fish, game and forests, and returned to the State for the same period \$227,261.00; in other words, it is more than self-supporting. Of the total amount paid back to the State \$211,508.80 was (cf. Biennial Report 1915-'16, p. 145) from fish and game. In other words, wild life in Wisconsin is largely paying for the conservation, not only of itself, but as well for the forest trees.

In Minnesota, Avery ('16, pp. 6, 39-42; '17; '22) estimated that the food use of game birds and fish has an annual value of \$2,000,000, the value of the tourist trade is \$1,500,000, and the commerce depending upon game and fish is \$3,000,000. This gives a total of these related items of six and a half millions of dollars annually. The income of the State Game and Fish Commission is made by an appropriation, and all revenue from the Commission goes to the State or to the counties. For 1915-'16 the revenue from wild life sources was \$154,499 and the expenditures were \$113,321. This estimate does not include revenue from Lake Superior, from which in the vicinity of the Duluth-Superior harbor (Minnesota and Wisconsin) there was received in 1915, 9,800 tons of fish (including a small amount from Michigan), valued at \$908,891. From these figures it is seen very clearly that wild life is capable of doing even more than its share in conservation. Forestry in the same state received in 1918 an appropriation of \$50,000.00, a wholly inadequate sum. The recent one hundred million-dollar forest fire near Duluth is a natural consequence of such a short-sighted policy, and fish and game are both destroyed by such fires (cf. *Amer. Forestry*, Vol. 24, pp. 643-654; 1918), as well as hundreds of human lives. A conservation commission, properly financed, may be the solution of this problem, provided, of course, that "politics" can be eliminated.

As a result of a special study of wild life resources in relation to forestry, parks, and the summer resort industry, in Michigan,

Wisconsin and Minnesota, Avery ('22a) found that during the years 1919-'20 and 1921 the number of game birds killed in Minnesota amounted to a total of 5,994,400, or in round numbers about 6,000,000 each year. If these pieces of game are worth on the average \$1.00 it means \$6,000,000 per year from the game birds alone. The total number of deer killed in these three states during the same years totaled 153,858 deer, which at \$30.00 each totals \$4,600,000. He gives certain general estimates which I quote verbatim as follows:

MICHIGAN (1920)*

	Production	Value
Commercial fisheries, lbs.....	24,000,000	\$2,965,931
Angling, etc., lbs.....	2,850,000	1,275,000
Game birds.....	719,589	701,601
Deer.....	25,000	625,000
Small mammals.....	1,296,552	648,776
Fur-bearing animals.....		3,000,000
Total.....		\$9,216,308

WISCONSIN (1921)*

Commercial fisheries.....		\$1,350,970
Angling, etc.....		2,125,000
Game birds.....		2,333,000
Deer.....	4,500	216,000
Small mammals.....		550,000
Fur-bearing animals.....		1,341,000
Total.....		\$7,915,970

MINNESOTA (1921)

Commercial fisheries, lbs.....	30,000,000	\$3,000,000
Angling, etc., lbs.....	7,000,000	3,000,000
Game birds.....	1,761,062	1,161,062
Deer.....	20,000	600,000
Moose.....	300	30,000
Small mammals.....		500,000
Fur-bearing animals.....	631,140	2,399,200
Total.....		\$11,290,262

Total value for three states, \$28,422,540.

Commenting on the above table Avery ('22a, p. 2) remarks: "It should be borne in mind that the above figures represent merely the annual income from the permanent capital stock. Figured at six per cent income the capital investment on which we are collecting this annual dividend would amount to \$472,326,800." To get the full force of this we should recall that all these returns are under restricted and relatively imperfect management, which could be greatly improved.

* Estimates supplied by Conservation Commissioner.

While discussing the economic value of wild life it is well to recall Forbush's ('12, p. 500) statement: "In the older parts of the country, where wild-fowl are now much diminished in numbers as compared with their former abundance, much of their economic value to the inhabitants consists in their attraction for sportsmen. Massachusetts sportsmen frequently have asserted that in the pursuit of ducks and geese they spend from \$5.00 to \$25.00 for every bird they kill, and were wild-fowl numerous throughout New England, large sums would be distributed annually by sportsmen to hotels, boatmen, farmers and guides, and the business of country merchants would be increased." (For data on the market prices for game animals, see Oldys, '11.)

Holmes ('16, p. 291) says of the Southern Appalachians: "The future forests will therefore be much more suitable for grazing deer and elk than sheep and cattle, and the former can be made to yield a much greater revenue to the Government and more valued returns to the people of the country. Permit fees of \$5 or \$10 for killing a buck, and \$20 to \$25 for an elk, will bring in more revenue than pasturing cattle at 40 cents per head."

Palmer ('22, pp. 12-13) has summarized the estimates, made by several of the State game officials, of the value of game as follows: "The fish and game of Idaho have been estimated to be worth \$1,000,000 per annum. The Conservation Commission of Louisiana estimates the number of waterfowl killed in a single season at 371,654, a total which includes many of the smaller species, but the value of which may be estimated at from \$150,000 to \$250,000. Michigan places the annual food value of its game animals, birds, and fish at \$500,000 and the value of the insectivorous birds at \$10,000,000.00. . . . Oregon, in 1914, estimated the value of its game at \$5,000,000. Vermont values its fish and game at \$500,000 per annum, 'equivalent to a dividend at the rate of 4 per cent on \$12,500,000'." Palmer ('22, p. 25) makes the following estimate of the value of big game: "It is of course impossible to estimate accurately the value of this big game. Some of the elk, moose, and sheep belong to species found nowhere else in the world and are now represented by small herds. Unlike most things which have a definite value, wild game can not always be replaced when it is exterminated over an area. No market value in the ordinary sense of the term can be placed upon such animals. If buffalo should be valued at \$200, antelope and moose at \$100, elk at \$75, and sheep and goats at \$30 each (all conservative figures, at least for animals for propagating purposes), the total value of the big game other than deer would be not less

than \$5,000,000. Deer are much more abundant than any of the other kinds of big game, and with the figures available it is probably safe to estimate that their value is at least twice that of other big game. This would give a value of \$10,000,000 for deer and a total value of at least \$15,000,000 for all the big game in the United States exclusive of Alaska."

Let us now turn to Table No. 2, summarizing the amount of game in the National Forests and see what they are worth from the standpoint of finance. Suppose that in round numbers there are in 1925, 600,000 deer in the National Forests and 150,000 other large game animals, making a total of 750,000 big game. If each is valued at \$25.00 per head the total value of the game is \$18,750,000.00, or capitalized at 5% this is the equivalent to \$375,000,000.00. It is therefore probably safe to value the big game as being worth at least \$25,000,000.

Nelson ('23, p. 373) using much the same data as Palmer concludes that: "The following states have at one time or another placed a money value on their annual kill of wild life: Idaho, \$1,000,000; Michigan, \$4,975,377; Minnesota, \$4,690,262; New York, \$3,239,277; Oregon, \$900,000; Pennsylvania, \$6,000,000; Vermont, \$502,000; and Wisconsin, \$4,440,000; or a total of \$25,746,916, in the eight states mentioned. Capitalized at 6 per cent interest, this would indicate an annual dividend on approximately \$430,000,000. Granted that a third of the wild life of the United States is found in the eight states mentioned, the estimates of \$1,000,000,000 for the United States is conservative." And to that must be added Alaska, Canada and other British territory, if we are to form an idea of the conditions north of Mexico.

Titcomb ('14, pp. 8, 9) has made the following estimate of the annual value of fish in Vermont: "It is conservatively estimated that the annual catch of brook trout in Vermont is at least 200,000 lbs. which, at the market price netted to commercial trout raisers, may be valued at \$100,000.

"It is conservatively estimated that the ponds and lakes of the state, containing ordinary fishes worth in the home market at least 12 cents per pound, yield an annual revenue of 60 cents per acre. There are something over 375 ponds in the State having an area of 116,200 acres which, at 60 cents per acre, gives a value of \$69,720. Many of the ponds figured in this estimate afford good fishing for brook trout, lake trout and landlocked salmon worth from 20 cents to 50 cents per pound, and lakes of this character must give an average yield under present conditions of at least \$1 per acre. If, therefore, there be added to the value of the yield for trout the amount of

\$5,000 the estimate will still be a very conservative one." To this he adds \$75,000 from the Lake Champlain waters in Vermont, and concludes: "The sum total of these items amounts to \$249,720 which at 4 per cent is the annual dividend on \$6,243,000 from Vermont's natural fishery resources."

Overton W. Price ('09, Vol. 1, p. 51) has made the following statement: "The fish which live in forest waters furnish each year \$21,000,000 worth of food, and not less than half as much is furnished by the game which could not exist without the forest."

In addition to the gross revenue derived by the State and the community from fish resources, it is worth while to consider what individuals may also derive directly from this resource. An effort was made to learn what was known of the value of trout streams, but nothing of much value was learned. A case came to the Court of Claims, at Syracuse, New York, about the value of a certain Adirondack trout stream, which a paper company owned and for which they wished the State to pay when it was added to the Adirondack Park. The paper company put a valuation on this land of \$100 per mile for 18 miles of this trout stream (cf. Syracuse Post-Standard, Nov. 17, 1916).

Bean ('16, p. 3) has estimated that in New York the inland licensed net fishermen in 1915 secured 5,886,031 pounds of fish, the estimated value of which is \$296,362.91. Carpenter ('21, p. 21) upon the basis of the game license returns for 1918 makes the following calculations: "The game and fur-bearing animals of New York State, if capitalized, are worth not less than \$53,000,000; they return an annual dividend of more than \$3,200,000; and they cost the State for their protection and increase the nominal sum of \$182,000. This cost of protection and increase is thus less than six per cent of the annual dividend."

The financial returns from the fisheries of the Illinois River have been mentioned as well as those from the Great Lakes and other inland waters. The most intensive methods of fish culture are those of ponds. The financial aspect of this has never been very seriously investigated in America. The best summary which we have of this subject is that made by Alvord and Burdick ('15, p. 83) with the help of Dr. S. A. Forbes. Alvord and Burdick make the following comments on the table which follows; see Table No. 13.

"As bearing upon the future possibilities in the Illinois River valley, it is instructive to quote the somewhat detailed figures of one commercial fish farm in Germany as shown in Table No. 1. It will be observed that 202 acres of water surface divided into 52 ponds, with a total investment of \$29,094, including land, returned

gross \$37.30 per acre at an annual cost including four per cent on the investment of \$27.15 per acre, leaving a net profit of \$10.15 per acre. The net return on the investment exclusive of interest was 11 per cent.

"It is instructive to note that the overseer received only \$432 per year and that the total expense for labor was only \$1,140; further, that the average price received for fish was about 13.6 cents per pound. At present American prices for labor and for fish, the yield from this farm would have been very much less than the running expenses. Where suitable ponds exist, however, or can be cheaply constructed on land not otherwise useful, as is the case in many of the levee districts of the Illinois River valley, it is possible that intelligent fish culture as an adjunct to farming can be made practicable. It is understood that experiments along this line are now being made by farmers in the valley. It would be well if their efforts in this direction could be so supervised by the State that the experiment is fairly tried."

TABLE NO. 13—SHOWING FINANCIAL STATEMENT OF A GERMAN POND FISHERY

(From the *Fischerei Zeitung*, 1907, p. 517)

	Total		Per acre	
Income from sale of fish. *(Principally carp at 13.6 cents per pound)	.....	\$7,535 94	.....	\$37 15
Expense and fixed charges:				
Four per cent on \$29,094.....	\$1,163 76			
Land and building tax.....	53 04			
Fire insurance.....	3 84			
		\$1,220 64		\$6 05
Repairs to buildings.....	\$76 08			
Renewal of implements.....	72 00			
Renewal of gates and sluices.....	92 40			
Salary of overseer.....	432 00			
Other help.....	708 00			
Transportation charges.....	204 00			
Fertilizers.....	172 80			
Lime.....	124 08			
Fish food.....	1,788 00			
Office expense.....	151 20			
Sickness and medicines.....	13 20			
Loss of fishes.....	433 92			
		4,267 68		21 10
Total.....	.....	\$5,488 32	.....	\$27 15
Net profit.....	.....	\$2,046 72	.....	\$10 15

* The sales of fish in normal years from this property averages as follows:

Carp, pounds....	47,178
Tench, pounds....	2,866
Trout, pounds....	875

Total, pounds.. 50,919
[252 pounds per acre]

Area of water surface 202 acres divided into 52 ponds.

Value of Plant:

Land.....	\$11,527 20
Pond system.....	8,902 80
Buildings.....	2,808 00
Fish.....	4,126 80
Old inventories.....	343 20
Gates and sluices...	1,386 00

Total..... \$29,094 00

As to the financial value of deer, Merriam ('09, Vol. 3, pp. 317, 318, 320) states that: "The number of wild deer killed annually in the United States is not known, but the annual kill in six of the northeastern states (Maine, New Hampshire, Vermont, New York, Pennsylvania, and Michigan) is about 35,000. The resulting venison at 20 cents per pound is worth considerably more than a million dollars." . . . "From the rapidity with which the license system is spreading, it is obvious that in a very few years it will be general and that the annual revenue from this source alone will exceed \$3,000,000—a sum considerably in excess of that required for the support of an ample warden service; so that the returns from sale of licenses will be a source of direct revenue for the State." . . . "In 1905 the funds for game protection amounted to nearly \$1,000,000, of which more than \$500,000 was received from fees for hunting licenses, about \$350,000 from specified appropriations, and the remainder from receipts from fines and miscellaneous sources."

Pratt ('18, p. 33) estimates that from 8,000 to 10,000 deer are killed annually in New York. The value of these at \$20 each amounts to \$200,000 or at \$30 each to \$300,000.

Merriam ('09, Vol. 3, p. 322) summarizes for 1903 and 1905 the total amount of fees collected from hunting licenses for the United States. These amounted respectively to \$335,300 and \$584,600. Similar data collected by Palmer ('04, pp. 33-41) are for various states and for certain Canadian provinces.

Recently Sauers ('22) has compiled the statistics of the game warden service of the United States, and although there is a lack of uniformity in the different states regarding license systems, and a few state officials failed to reply, the general result shows that the total income from resident and non-resident licenses produced \$4,768,300. The fines and costs produced a total of \$467,300, and the total expense of the warden service was \$2,538,350, a net gain of \$2,697,250. Thus Merriam's prediction of 1909 has been abundantly realized.

A recent study of deer breeding compared with that of domestic stock has been made by Phillips ('16). His estimates are based upon Pennsylvania conditions, where he says that there are about 17,000,000 acres of forest and brush suitable for deer. He estimates that to fence four square miles, or 2,560 acres, would cost about \$4,000. Of such an area he says (l. c., p. 6): "An enclosure of this kind would provide food for at least 100 deer, 10 does to one buck, with their annual increase of not less than 150 fawns, to be

sold the winter following the spring of their birth." This increase at \$20 each would bring \$3,000 per annum.

Riley ('15, p. 178) remarks that: "Within the last two years the State of Wyoming has received from \$20,000 to \$25,000 from the sale of game licenses, and the cost of administering the game department has been about half that amount. The purchase of residence licenses at \$2.50 and the non-residence license at \$50 each is, of course, a small portion of the money actually spent in the hunting region. It has been found that parties going out in the immediate neighborhood for deer would average from \$30 to \$36 each, while in the more attractive big-game sections, non-resident parties, amounting to from one to two hundred yearly, would spend from \$400 to \$600 each."

Recently Phillips ('23) has made rather elaborate estimates of the annual kill of game in Pennsylvania for the year 1921. He estimated that sportsmen killed 18,435,294 pounds of game, valued at \$5,500,000; see Table No. 14.

TABLE NO. 14 — ESTIMATED TOTAL OF GAME KILLED IN PENNSYLVANIA
Season of 1921

	47,000 licensed hunters reported killing	Weight killed by hunters reporting	Estimated kill of animals by 614,132 men	Estimated weight of animals killed by 614,132 men
Rabbits.....	440,446	1,101,115 lb.	5,755,031	14,387,572 lb.
Squirrels.....	63,120	63,120 lb.	824,779	824,779 lb.
Ruffed Grouse.....	35,996	53,994 lb.	470,425	706,638 lb.
Crows.....	22,417	.....	292,941	.....
Black Birds.....	19,268	4,817 lb.	251,794	62,948 lb.
English Pheasant.....	2,966	8,157 lb.	38,690	106,398 lb.
Quail.....	9,593	3,597 lb.	125,344	47,004 lb.
Shore Birds.....	1,864	700 lb.	24,505	9,212 lb.
Hare.....	7,690	30,760 lb.	100,410	401,640 lb.
Raccoons.....	5,910	53,190 lb.	77,381	696,429 lb.
Wild Geese.....	292	2,336 lb.	3,814	30,512 lb.
Wild Ducks.....	9,567	28,701 lb.	125,038	375,114 lb.
House Cats.....	6,122	.....	79,837	.....
Wild Turkeys.....	356	4,272 lb.	4,654*	55,848 lb.
Deer.....	370	48,100 lb.	4,840*	629,200 lb.
Bear.....	39	7,800 lb.	510*	102,000 lb.
Total.....	626,016	1,410,659 lb.	8,180,053	18,435,294 lb.

* Counted by Game Protectors.

Note: Based on the reports of 47,000 hunters made to the Game Commission of Pennsylvania.

Percentage of licensed hunters reporting, 10½ per cent.

In this paper Phillips quotes (l. c., pp. 14-15) the following from F. C. Wolcott: "The cost to the State for securing and maintaining an annual output of approximately seven and a half million dollars was in:

	1920	1921
General activities.....	\$411,496 70	\$527,588 40
Bounty system.....	132,572 72	137,763 51
	<hr/> \$544,069 42	<hr/> \$665,351 91

"This money has been raised for several years by an excise tax in the form of a hunting license so that those who are directly benefitted, pay the cost. . . . The gross yield from it is more than ten times the cost, and the gross yield of \$7,500,000 less the 1921 cost of \$665,352 shows a net return of \$6,834,648, which is 6 per cent on \$112,000,000. This is a fair estimate of the capital value of this resource to the State of Pennsylvania."

Upon this Phillips remarks (p. 15): "It is interesting to note that the report of the Pennsylvania Department of Agriculture for the same year valued the livestock on our 215,000 farms as follows:

"Milk cows	\$50,946,852 00
Other cattle	19,645,303 75
Sheep	2,239,209 75
Swine	14,036,928 25
Chickens	15,270,179 00
Bees	653,896 70

\$102,792,369 45"

In the preceding section several estimates have been given of the value of fur-bearing animals to various states as in Michigan, Wisconsin and Minnesota, where they annually produce a crop valued at over a million dollars. Several authors have assembled statistics of the value of this business and attention is called to those by Dearborn ('20), Ashbrook ('22), Taylor ('13), and Bryant ('15).

In New York State Pratt ('18, p. 56) has published Mr. J. M. Cooper's estimate of the annual production of fur for 1917-'18, giving a total of \$1,175,320. Mr. Cooper kindly made an estimate for me for 1918-'19 as follows:

	Number taken	Average price	Total
Skunk.....	260,000	\$4 25	\$1,105,000 00
Mink.....	3,000	8 00	24,000 00
Raccoon.....	10,000	3 50	35,000 00
Red Fox.....	5,000	15 00	75,000 00
Muskrats.....	300,000	1 60	480,000 00
Ermine.....	10,000	85	8,000 00
Bear.....	30	20 00	600 00
Fisher.....	25	40 00	1,000 00
Otter.....	25	20 00	500 00
Marten.....	200	5 00	1,000 00
Total.....			<hr/> \$1,730,100 00

A similar estimate was made for the season of 1923-'24 as follows:

	Number taken	Average price	Total
Skunk.....	175,000	\$2 25	\$393,750 00
Muskrats.....	200,000	1 60	320,000 00
Mink.....	2,500	10 00	25,000 00
Raccoon.....	15,000	4 00	60,000 00
Red Fox.....	5,000	12 00	60,000 00
Gray Fox.....	300	2 50	750 00
Ermine.....	5,000	75	3,750 00
Marten.....	200	5 00	1,000 00
Bear.....	25	18 00	450 00
Fisher.....	25	60 00	1,500 00
Otter.....	15	20 00	300 00
Total.....			\$866,500 00

The above estimate was made January 24, on which Mr. Cooper comments: "At the close of this season I think the total amount in round numbers would be one million dollars."

The statistics of income derived from the Alaska furs shows the importance of that industry there. Between 1912 and 1923, in round numbers 2,730,300 skins were shipped from Alaska valued at \$12,988,900, or about \$13,000,000 exclusive of the fur-seals. The fur-seals from the Pribilof Islands, as shown in Table No. 7 (p. 593), have produced between 1909 and 1923, 226,515 skins, and those sold up to 1921 make a total of about \$6,900,100, making a total revenue of nearly \$20,000,000 during this period. In this connection we may well recall that in 1867 we paid Russia \$7,200,000 in cash for Alaska. It is not unlikely that if the fur-bearing animals of the Alaska mainland were developed under careful supervision the crop could be more than doubled within a relatively short period.

The production and value of Canadian furs has been put upon a sound basis by their Dominion Bureau of Statistics, Fur Branch, which has collected data, beginning with the season of 1919-'20 as follows:

	1919-20	1920-21	1921-22	1922-23
Number of Pelts.....	3,600,004	2,936,407	4,366,790	4,963,996
Value of Pelts.....	\$21,387,005	\$10,151,594	\$17,438,867	\$16,761,567

These pelts, numbering from about 3 to 5 million annually, and producing from 10 to over 20 million dollars per year, are thus seen to produce a very important industry, as one has reason to expect from a region so extensively forested and with a climate so favor-

able to these animals (cf. *The Forests of Canada*, 1923, pp. 1-45. Canadian Dept. Interior, Forestry Branch).

At present we can not determine accurately the annual production of manufactured furs for the United States. Among the most reliable sources of information are those collected by Mr. John F. Mallon, actuary of the Fur Dressers' and Fur Dyers' Association of New York City. His published data begins with 1918 and at the present time he estimates that his records include about 90 per cent of the fur dressing and dyeing done in this country (cf. Mallon, '20-'22). He gives the following record of the number of furs dressed by his association:

1918	:	25,300,100	1921	29,900,700
1919	:	27,900,600	1922	30,240,100
1920	:	26,500,200	1923	33,700,700

The magnitude of the fur industry in the United States is indicated by the opinion of leading men in the industry who state that it aggregates an annual turnover of about \$1,000,000,000. As a rough estimate it is thought that the wholesale value of the manufactured furs, produced in the United States, is from \$200,000,000 to \$250,000,000 and the materials entering into their manufacture is about half that amount. Since this industry, as has been pointed out previously, is centered in New York City, the State has a primary interest in the problems of this industry.

Mallon ('20, p. 267) has said: "The fur trade is one of the greatest industries of the country. The progress we have made in the past five or six years in all branches closely parallels that of the automobile business. To give you some idea of the magnitude of this business take the leading skin, the muskrat; this skin is to our trade what the United States Steel is to the stock market—the barometer around which the prices of all other skins revolve, advance and decline with the demand of the market. Follow the course of this animal from the time it has been trapped, through the various stages of dressing and dyeing and manufacturing, until the finished garment has been produced. You will find on this one item alone that you have an annual business in excess of \$200,000,000."

In a recent communication Mr. Mallon writes of the muskrat: "During the year 1923 we dressed 9,723,025. There were exported abroad 5,122,232 and imported 2,659,146. Adding the difference between the imports and exports to the amount handled by our members gives us a raw fur market on muskrats for the year of about 12,200,000 skins."

Summary of the Financial Situation. Such evidence as the preceding, on the income derived from forest animals, might be increased greatly, but enough has been presented to make it clear that in the wild life of the forests, the fish, game, fur, and forest grazing animals, we have an extremely important financial resource, so important indeed that it can no longer be slighted with impunity in comprehensive forestry plans.

As a rule American foresters have been accustomed to consider forest finance only with regard to the timber crop, in spite of the fact that in the National Forests grazing is one of the largest sources of revenue, and this is an annual revenue that does not involve a long time crop, as in the case of timber. That wild life—fish, game and fur—should be included in forest finance has received even less recognition. There seems also to be a tendency to attempt to shift considerable financial responsibility to our systems of taxation. A recent investigation made in New York State by Cormick (Report of the Special Joint Committee on Taxation and Retrenchment,—Legis. Doc. No. 91; 1924) does not however give much encouragement from this source, as he shows that current taxation of timber lands is relatively less than on farm lands.

The time is arriving when those who consider themselves as practical men of affairs can no longer ignore the implications which are here so clearly revealed. These facts are equally definite in showing that under proper management, particularly under a unified management of fish, game, fur and forests, it is possible to produce large numbers of wild and domestic animals and to derive millions of dollars from them. This is now being done; it is not a theoretical question. It can be increased greatly and surely it has that destiny. And, finally, when we learn of a deficit in the operation of large forest areas should we not raise the question: Other things being equal, is not a deficit due to a defective business management, or legal hindrance which involves a lack of unified control, and which therefore ignores or neglects the proper use of domestic animals, wild life, and the recreational uses, as a source of annual revenue?

METHODS OF DEVELOPING CONSTRUCTIVE POLICIES

The Need of Leadership. The preceding discussion of the animal problems of the forest has shown that we are dealing with a problem of considerable magnitude and that there are serious errors in current circulation and grave defects in current practice, which interfere with the best management of this exceedingly valuable

resource. It was further shown that even now it is capable of a high degree of productiveness, is the source of much income, even, in fact, often the leading source for the practice of conservation. Such considerations as these show that contrary to current opinion, the animal problem is at the present time one of the most important and practical problems in forestry. In view of this relation it is evident that there is a most urgent need for suggestions, support, and investigations contributing to the development of constructive policies for the improvement of the present situation.

Leaders in forestry should reflect carefully on the fact that their own degree of personal interest in problems is not always a safe measure of their value, because interest and importance are not synonymous terms. Interest is often controlled by proximity, personal relations, by the clamor, or the unscrupulous methods of an advocate, and even by a traditional training, but importance depends upon the potentialities or merits of the problem in terms of human welfare. Of course, to distinguish these is often very difficult, but this is both the opportunity and the responsibility of an able leader. It is therefore one of his primary duties to get, and to keep interested in important things. The criterion then, by which we must estimate values and guide action, is expressed in the answer which may be given to the question: In what manner does it improve human welfare? It is important therefore, to realize that there is no general permanent solution for this problem, it must be solved as often as the conditions change. The main function of a leader is to hasten this solution or adjustment, which broadly speaking would probably take place without him, but at a much slower rate. He thus needs orientation, by a broad survey of the field and by continually re-estimating values. At present, as has been stated, this is our greatest need. This orientation will require an open mind, as free as possible from bias, with a willingness to see things as they are, rather than as they appear on superficial examination, or as partisans wish them to appear. There is needed a willingness to draw conclusions in harmony with the facts, and sincerity enough to support them intelligently, even in advance of their general popular recognition. These are qualities which should be developed and encouraged in foresters and their allies—under whatever name they pass.

In forestry and conservation several types of leaders are urgently needed. The ideal would combine the good features of all; sufficient intellect, energy, ideals, and poise, to handle any problem; but such men seem to be the product of nature, rather than of education, and

are very rare. Of the more commonly available kinds, however, there are two types, which it seems to me, are now very urgently needed. These are first, research students or investigators, who can discover solutions for every kind of solvable forestry problem where knowledge is lacking. These are the scouts and pioneers, who must find the way, before others can follow intelligently and in safety. Action, in advance of knowledge, may be necessary, but it can not be intelligent, and human life pays dearly for using this method. The need of careful investigation before action, has been well expressed by Bagehot ('73, pp. 186-187) who has said: "It is certain that we should have been a far wiser race than we are if we had been readier to sit quiet—we should have known much better the way in which it was best to act when we came to act. . . . If it had not been for quiet people, who sat still and studied the sections of the cone . . . infinitesimals . . . [and] the heavenly bodies—our modern astronomy would have been impossible, and without our astronomy, our 'ships, our colonies, our seamen,' all which makes modern life, modern life could not have existed. Ages of sedentary, quiet, thinking people were required before that noisy existence began. . . . Most men inherited a nature too eager and too restless to be quiet and find out things; and even worse—with their idle clamour they . . . would not let those be quiet who wished to be so, and out of whose calm thought much good might have come forth." This phase of leadership is one which is easily grasped in the abstract, but in practice it is neglected so often that it needs the utmost emphasis. It is the practical recognition of this and all that this implies, in rewards, honors, compensation, and opportunity which should be the basis for rapid and permanent progress in forestry, and conservation, as in other lines.

The other kind of leader greatly needed is the skilled executive. In him the leading traits are energy, and a moving knowledge of men, a proper balance, and with a broad outlook utilizing the latest and best information derived from all investigators, and with real insight into the kinds and conditions of men as related to human welfare. He is then in a position to do much for forestry, and for the development of society. When however, there is a lack of poise, and action precedes knowledge, we meet with what is so graphically expressed by Bagehot in the words, "too eager and too restless to be quiet and find out things," and gross errors are inevitable. We see in these limitations why the two types of leaders should work as a team, in order to get sane balanced results, of relatively permanent value. The rapid growth of our nation and our extensive natural

resources have tended to over-emphasize the importance of the executive in the public mind as well as in technical circles, so that it is only very recently that even our larger business men and public officials have partly awakened to the relative importance of the investigator, and have begun to give substantial support to research. Even at present it is mainly industrial research, the factory problems, which have impressed them. The most hopeful feature, however, is perhaps to be seen in the fact that a good start has been made, and considerable inertia has been overcome. We frequently hear from executives of the great need for others of their own kind, and at the same time investigators see an equal need in their own line. Many large business concerns have become self-limiting for lack of executives, because the investigators have enabled them to produce more rapidly than business and society has power to assimilate, under present economic and social conditions. The limiting factor in this case appears to be social, and this suggests that business and forestry in order to make further advance, may have to give more attention to the social aspects of their problems, before further large advances can be made in certain directions. The laws of limiting factors apply to business as to other biological activities (cf. Adams, '19a, p. 481). It is the main function of the executive and the investigator to resolve these limiting factors by cooperative effort.

There is thus a real need for leadership in forestry, and such leaders should have a broad view of the situation, and in addition to their general mental attitude, they should of course also have a certain detailed knowledge of forest life, and its applications, as that is all that is really distinctive of the forester. Modern forestry is such a large field that no man can now drive all its branches abreast, and specialization has become necessary. A knowledge of forest animal life is one of these large specializations, and yet the profession as a whole now needs, as never before in its history, a firm grasp of the general relation of animals to forestry, because the animal problem is now in a critical stage, where errors will do the maximum amount of injury. The silvicultural aspect of forestry was the first to be developed in America, and grazing was the first phase of the animal problem to receive fair recognition, and still later came fish and game; but neither of these problems have received adequate public recognition and appreciation, either in the profession or in forestry schools.

This lack of technical training is conspicuously revealed in the case of many officials who deal with the fish and game of forests. As one examines the various reports of the State Fish and Game

Commissions he is strongly impressed by the relatively average quality of the ability shown in many of them. These reports are frequently written in a chaotic fashion, there is little or no logical organization of the materials, and the sequence of treatment is apparently accidental or traditional. The methods of recording the financial summaries is equally confusing. It is difficult and often impossible to draw safe conclusions from them, and often impossible to compare their results with those of other states, and in some cases even the expenditures are not given because the amount is not known. These conditions suggest that there must be a corresponding confusion in the minds of the officials; they have not thought out and do not fully grasp the relations of their own work. The really valuable and well prepared reports are in marked contrast to these. It is evident that all too frequently these men have had no technical training for their work, comparable to that of a trained forester or naturalist. This condition must surely change materially before much improvement can be expected. Without question one of the best ways to remedy this condition would be to take, as much as possible, the administration of conservation out of the hands of politicians, and furthermore the new men must not "play politics"! But even now if this change were made suddenly, there would be no adequate supply of technically trained men to take charge, because of the neglect of this training on the part of our educational institutions. The next logical step seems to be for the colleges of forestry or other institutions to meet this demand squarely, and train the men with both the technical knowledge and the proper ideals. The needs of such men will require a good training in general forestry, economics and sociology, combined with a special detailed knowledge of the ecology of fish, game, fur, and the domestic animals of the forest. Considerable emphasis should be placed upon the importance of ideals, because without these an essential to success would be left out. It will not be surprising if this fish and game work changes hands completely, within the next ten or fifteen years, falling into those of technical men. Similar changes have been taking place in allied fields.

As soon as the problem of training men arises seriously, and an effort is made to formulate definite policies, the defects in our knowledge become evident, and the need of further information becomes more and more keenly appreciated. At present we do not have a large body of trained foresters, with the special training necessary to solve the animal problems, and for this reason use must be made of men in allied lines who have a part of the training, and

the interest to undertake these investigations. As this work progresses, the probabilities are that the number of forest experiment stations will have to be increased considerably, and a full staff, including those who are interested in the general problems, as well as specialists, will be devoted to the solution of important animal investigations. Well trained forest animal ecologists should have charge of the animals in all the larger forests, who will devote themselves to the study of every phase of the relation of animals to forestry and to the public.

Development of Policies. In addition to the improvements in the training and personnel of the forestry profession, there is a definite need of formulating public policies. Such policies should be based upon the best available foundation, should be forward looking with regard to the future, and should be adaptable. Some of these changes have already been mentioned, and may be here summarized:

1. *Unified Control.* The unified control of all crops, animal and plant, from forest regions would solve many problems, as well as it would raise many new ones. It would help solve the problem of correlating all lines of activity, production, protection, finance, and harvesting of the crops in National and State Forests. It would help define the relative status of Federal and State control over all wild life, and would indicate just what kind of changes are most urgent. It would also help clear up satisfactory methods of controlling international and interstate waters. The recent treaty with Canada, and our Federal Migratory Bird Treaty Act, were very important pieces of legislation from many points of view. In this we now have an excellent precedent for International and Federal legislation with regard to migratory fishes in international and interstate waters. (For the most important recent discussion of this broad general interstate problem see Frankfurter and Landis, '25.)

The former head of the U. S. Bureau of Fisheries, Dr. H. M. Smith ('09, p. 385) has pointed out the urgent need of Federal and State cooperation, with regard to fishes, as follows: "The most important measures for the conservation of the fisheries lie in the production of a spirit of cooperation between the law-making bodies of the several States and this bureau, and it is believed that no State in which the bureau carries on fish-cultural operations should pass fishery laws without at least consulting the bureau. It would, perhaps, be well to go further and require that in case a State passes improper laws or fails to pass necessary ones, the fish-cultural opera-

tions of the Federal Government be suspended in that State until the matter is properly adjusted." That there is a real need for Federal and State cooperation is shown by the following (U. S. Fisheries Service Bulletin, No. 25, 1917, pp. 1-2), which states that the law applying to all fish cultural operations demands that: "No part of the foregoing amount shall be expended for hatching or planting fish or eggs in any State in which, in the judgment of the Secretary of Commerce, there are not adequate laws for the protection of the fishes, nor in any State in which the United States Commissioner of Fisheries and his duly authorized agents are not accorded full and free right to conduct fish-cultural operations, and all fishing and other operations necessary therefore, in such manner and at such times as is considered necessary and proper by the said Commissioner or his agents." Commenting on this condition Dr. Smith states: "It being fully established that the Texas laws are not adequate for the protection of the fishes and that the Commissioner of Fisheries and his duly authorized agents are not accorded full and free right to conduct fish-cultural operations, and this law being mandatory, I do not see how the Department can legally avoid the discontinuance of fish-cultural work in Texas."

These are examples of the complex legal problems which must be solved before much general constructive progress is possible. There are problems which will also require the advice and aid of men with much technical knowledge of animals as well as of law. And when once this problem is cleared up it will pave the way for much more constructive work. There is needed a thorough, open discussion of such problems. This phase is here listed first because the Federal Government is the largest single administrator of forest and park lands and waters, and its policy will influence all other smaller units. The State problems must remain in considerable doubt and confusion until the general Federal problem is adjusted. There are several methods by which such an adjustment might be made, and champions of the various methods should formulate their cases as strongly and clearly as possible, so that there will be a full and fair discussion of these problems before any further far-reaching decisions are made (cf. Frankfurter and Landis, '25; Chase, '13; Drummond, '16; Smith, '10; Lawyer and Earnshaw, '18).

The main defect in the management of game in the National Forests is expressed by Graves ('15, p. 2) as follows: "The keynote of National Forest administration is constructively planned utilization and development of all resources side by side, in such a way that one will not block others. . . . On the National Forests the

timber resource, the water resource, the agricultural resource, the mineral resource, and the recreation resource are all undergoing development under a general constructive plan. But the game is not. The game resource of the forests is not administered like other resources primarily because it is not under the jurisdiction of the Federal Government. The Federal laws do not give the Forest Service any authority in the matter. The utmost that the Forest Service can do is to cooperate with the state authorities by instructing its field force to assist, in so far as this can be done without interference with their duties as Forest officers, in enforcing the State laws, and by withholding from grazing use by domestic stock Forest lands which should be reserved for the support of game animals. . . . I look to the time when the wild life of the National Forests may be handled on sound principles of constructive development and use, such as now characterize the management of the timber, forage, water, and land resources. Such an administration would take account of the general needs of the public, the carrying capacity of the land that can be devoted to game, the needs of individual species and individual Forests, the coordinating of game administration in different localities and states, the use of the increment, and the intelligent adjustment of wild life control to the economic use of other resources. This, I believe can unquestionably be done without sacrificing one iota of state rights in the game, and along lines which will greatly increase the direct returns to the states in license money and the indirect returns in community upbuilding. . . . What should be done is to bring about, through coordination of different public agencies and new legislative authority, a system of wild life administration that will permit the building up of this valuable resource on sound and scientific principles.

“. . . In short, the States and the Federal Government must cooperate closely to secure the best results. . . . As owner of the land, responsible to the public for promoting its best use, the Federal Government rather than the States should prescribe the areas to be devoted primarily to game protection. The Department of Agriculture should have power to prevent the killing or taking of game on areas which it sets aside as game refuges, independently of state legislation; and its grazing policy must be governed not primarily by state legislation establishing certain areas as game refuges but by its own determination of the relative public needs involved. It should also determine the amount of game which may be taken each year without depletion of the supply, and should recommend to the states the legislative provisions desirable to insure utilization of the

increase, and no more. The conditions under which the game may be killed should be fixed by the State." A recent advance in the Forest Service is thus stated by Graves ('18, p. 25): "A new regulation has been promulgated prohibiting entering the National Forests with the intent to kill game in violation of State laws. It will bring cases of such violation into the Federal courts, and will thus supplement and strengthen the present procedure for game law enforcement."

In this connection the following suggestion of Leopold ('18, p. 408) is of special interest: "The legal basis for putting it into effect would consist of a simple Federal law authorizing the issuance of hunting permits. (Authority to issue such permits, by the way, is already vested in the United States, but it would require an act of Congress instructing the Secretary of Agriculture to exercise it.) It will be seen that no right, title, or interest of the State is in any way interfered with. . . .

"It should be noted that the proposed system of Federal hunting permits leaves the fixing of open and closed seasons to the State, as heretofore. . . . But with Federal volumetric control of kill, who cares what the open season is, as long as it is within reason? With the annual kill under regulation, open seasons are no longer a vital factor. The necessity for long closed season is done away with."

It should be emphasized, as stated elsewhere, that not only should this law be extended to game and fur-bearing animals as advocated above, but it should, with the same logical and practical validity, be extended to fish, and thus establish once for all the complete legal status of all wild life in our Forests.

The Forest Service is today the custodian of one of the greatest Federal public resources, the forests and wild life. To the degree that public confidence is maintained and the service is able to keep a proper balance between its centralizing and decentralizing functions, the proper balance between investigation and administration, and can avoid the evils of bureaucracy, additional power will be granted to it, until ultimately the Service possesses complete control over Federal forest lands. At present the divided authority is a source of weakness, but it contains an element which if properly coordinated, may be utilized to great advantage as a desirable decentralizing check on Federal bureaucratic tendencies. The proper balance between the Federal and State Governments would establish soundly the public ownership of fish and game in the hands of the Federal and State Governments. By a system of reciprocal adjustments,

similar to those which have been suggested, there would be a cooperative management. This supplemented by a deliberate decentralization policy of the Forest Service would tend to check bureaucratic tendencies, and maintain permanent public confidence.

When the National Forests were first established there was a rather natural hesitation, in a number of the Western states, about the advisability of allowing such large areas in these states to pass to Federal administration, and legislation was made to check that tendency. The efficient administration of the Forest Service has now turned the tide of feeling (as in the case also of grazing management) to such a degree that the legislature of Idaho memorialized Congress (Graves, '18, p. 10) proposing that an area of about 1,120,000 acres, known as the Thunder Mountain Country, be made a part of the National Forest, because in part, of the protection and utilization which it will afford to grazing and wild life; or as the memorial expresses it, this plan will "give adequate protection to the game animals, birds, and fish; establish a system of regulated range use, thus conserving and perpetuating the forage resources." The Forest Service approved of this plan. This is an example of the advantage of securing the proper reciprocal adjustment between the Service and the State with regard to wild life and grazing. No more propitious circumstances could be desired to make this adjustment than when a State seeks such Federal cooperation. This is the opportunity to establish legally a provision for Federal fish and game management and the income derived from such cooperation should be shared by the Service and the States, as in the case of other funds from the Forests, which in the past have contributed to the support of schools and roads. The funds from wild life and grazing should, in part at least, be used in maintenance of these and other conservation work. There is existing provision for the grazing income. This would be a fair plan for the solution of the problem of local revenue.

An important method of securing and retaining public confidence will be by maintaining a proper balance between the investigative and the executive functions. In the past the two functions were for a time intermingled, and much prominence has been given to the executive side, but by expanding investigation to include all phases of forestry, this defect could be remedied. This plan would not limit research almost solely to silviculture, but would include fish, game, and other animal problems, as well as the economic and social aspects directly related to forestry. By this method a close contact with the needs of the country would be maintained, and public

opinion will be understood in advance. There should also be cultivated, from the outside, a healthy and stimulating discussion of its policies, and much encouragement should be given to constructive criticism. (Cf. Adams, '25b, pp. 587-593.) It is upon these methods that public servants must in the long run depend to a large degree, for measuring the value of their services. In advocating unified control over forest life it should not be assumed that this necessarily means extreme centralization, with innumerable laws blanketed over the whole country, without regard to local conditions. That would be nothing less than a calamity. There should be unified control, with a large element of flexibility, provided for by regulations made to meet local conditions to check bureaucratic tendencies, and to develop local responsibility.

2. *Federal and State Policies.* As soon as the Federal and State legal problems are adjusted there will be no longer a valid excuse for the lack of constructive policies or programs for the handling of forest animals. We need such provisional policies to be definitely formulated, as this is the most rapid method of testing out our knowledge and learning where it is defective and needs rebuilding. Even at the present time it is highly desirable that these provisional working plans should be published, as a means of clearing the atmosphere, and of pointing to the most important subjects awaiting investigation and adjustment (cf. Adams, '25b).

3. *Systematic Research.* The two preceding classes of problems are so complex that no one would pretend to have the necessary data upon which to base a just solution of the problem. If this is granted, the only way to resolve such difficulties is to **make some plan** which will secure the necessary information, and this means deliberate systematic investigation. This is the attitude of research (cf. Adams, '16a).

By systematic research I mean the taking up of problems which promise important results, and which will possibly require considerable time to solve, and necessitate continuity of plan and sustained supervision to elucidate. Such work is commonly that of institutions, some of which will require team work on the part of several persons. Small problems may be handled by one person single-handed, but there are certain problems which are too large, or too important to wait for results by such relatively slow methods. Why should a Nation or State stand waiting for years for the solution of a problem, when ten men could probably solve it in a few months or in a few years? Of course there are many problems which are

not so simple and will require many years for solution. The progress of forestry should not wait for outsiders to solve its own problems, or the torch of leadership will pass to other hands, who will appropriate the field, even though they do not have the claim of a natural affinity which forestry possesses. Viewed broadly research is not the luxury which some erroneously suppose it to be, but the very foundation of intelligent practical government, in spite of the fact of its slow recognition. Former Secretary Franklin K. Lane of the Interior Department, once said: "We have found the great secret that nature can be made to fight nature. But we must fight with her for our weapons. They are not handed to us; they are hidden from us. If man is to have dominion over this earth, he is committed to an unending search. He must bore and burrow, dig and blast, crush and refine, distill and mix, burn and compress until he forces nature to yield her locked and buried treasures."

Research in forestry is as essential as in other lines of human activity. Woodward has said ('14): "The experience of our race has demonstrated that by study and hence by understanding of this universe the roads to progress may be found. The methods of research are the methods of science. They are not of recent origin. . . . What is new about them is a widely general and rapidly increasing recognition of them, as the most trustworthy methods man has devised for the discovery of truth and for the eradication of error. . . . And thus the more striking results of research, quite commonly in the past attributed to wizards and genii . . . are now understood by the thoughtful to be products rather of industry, sanity and prolonged labor than of any superhuman faculties."

The Nation and the State are just beginning to realize that investigation in forestry problems is one of the urgent needs of the hour, and yet the industries which are, to a considerable degree dependent upon forest animals have been particularly backward in realizing and recognizing the relation which they bear to the whole situation. As previously remarked, we should bear in mind that investigations are needed not only on the side of production, but as well on the harvesting of the crop, and on its proper distribution to the consumer. Investigation, followed by education, is needed at every stage in handling this resource. I know of no example of a successful business man, who has acquired his money from forest animals, or from lumber, who has made a really important contribution of funds to advance research on forest animals. In several of the manufacturing industries, which are dependent upon detailed technical knowledge, there is a certain amount of appreciation of research, and some sub-

stantial support for it, but this stage has not yet been reached in this phase of forestry. At present practically all the support, in addition to that contributed by a few individuals, comes from the Federal and State governments. The education of foresters on many subjects must await investigation, because it is only after the solution of problems that others can be taught to apply them.

Since much progress is dependent upon investigation it is desirable that those interested in the industries should come in closer touch with those who are best qualified to solve their technical problems, but unfortunately there are usually few points of contact between business men and the scientific and technical investigators. As a rule the technical man, like the business man, has been preoccupied with his own work, and the two groups do not, unfortunately, intermingle—to their mutual disadvantage. This situation is rather abnormal because constructive work, in all lines of activity, in both business and science, depends upon many of the same qualities of mind, and such persons ought to readily understand one another. Some business men see this mental unity, as Vanderlip (*Business and Education*, 1907, pp. 34-35), who has said: "I know leaders in the business world, who have as little concern for personal reward in what they seek to accomplish as would be the rule with men engaged in scientific research. These men are devoted to certain commercial ideals. The making of money happens to be inseparably connected with those ideals, but the making of money is not the great moving force. . . . They have the same high type of imagination that usually marks men who attain eminence in any other line of activity. They are, in a large way or in a small way, as may be determined by this environment, using qualities similar to those that make great statesmen, great scholars, and great scientists."

Recently Mr. George W. Perkins ('21, pp. 55-56) in commenting on the isolation of these two groups of workers emphasized the fact that both parties were responsible for this condition, and urged that the investigators make more of an effort to inform the public of the degree to which modern progress has been dependent upon scientific discoveries. These discoveries have been, as he states, revolutionary: "The result has been a mighty conflict between the old laws of man and the new laws of science. One or the other has had to give way. As the man-made laws were the outgrowth of centuries of effort and cumulative human knowledge it did not seem possible that anything could come into the world that would set all this cumulative knowledge and experience to naught, and to do it

over night as it were. Such, however, is the actual situation; but a vast majority of the people of the world do not realize this, do not understand it. It is also true that even a large number of our more intelligent men have refused to accept the new conditions in which we live, and have insisted on continuing under the old system, following old precedents and practices. As a result, a mighty conflict has engaged us and will continue to engage us until our people and other peoples of the world realize that a mighty upheaval has taken place; that we have entered a new world of thought and action, dominated almost wholly by the discoveries of science within the last half century; that new codes of business morals, of finance, of industry are being set up, and that it behooves us all to give the best thought, the broadest vision, and the most unselfish devotion to the erection of a new structure that will be in harmony with the modern economic needs of our people. . . ."

"For the last twenty-five years the scientist and inventor, have almost daily placed in the hands of the merchants and the manufacturer some new instrument or device that has made it possible for him to speed up his business and reach out and do business at far distant points; some new device that has made it possible for a single human mind to do infinitely more business than any human mind ever did before."

Investigators are thus seen to be the catalyzers or hasteners of progressive changes, and in forestry there is no exception to the general rule. Certainly this is not an age in which to decry research, for to do so shows that the critic has not grasped the real situation. It is evident that there is abundant reason why investigators and business men should mutually understand one another. One important factor in this mutual understanding is, first of all, for the business man to see the fundamental disadvantage under which the investigator usually works, which more than any other factor produces the isolation seen and limits his productiveness. This point can be made clear if we recall that the work of the investigator is essentially that of a scout. Suppose the scouting airplane pilot were not only required to find his way but "on the side" as it were, to synthesize, from the thin air about him the fuel necessary for the maintenance of the power of his engine, and you have a close parallel with the usual condition of the investigator. He must find his way, fight with nature for his discoveries and inventions and at the same time, and "on the side," support himself and his family. This is asking a good deal of human nature. Here is perhaps the main limiting factor, which drives men into other lines of work, which

makes money getters out of them, while society blunders along in ignorance and confusion, conducting its campaign with a handful of scouts when the whole air over the land of darkness and ignorance should be full of them. And, finally, the investigator "happens to be inseparably connected with ideals" which bring rich rewards to business and to society, but as a rule do not come to him, at least when most needed, in any degree commensurate with his sacrifice and with the benefit conferred upon society. This phase of the subject has been well expressed ("Sweating the Scientist." *Science*, N.S., Vol. 39, pp. 635, 637; 1914) as follows: "But it may now be said that the scale of payment for science is purely a question of supply and demand. That is so—and the same principle governs the case of sweated industries of all kinds. In the latter, the employer exploits the necessities of a crowded and poor population in order to have his work done at the cheapest rate. As regards science, however, the employer is the public itself, and the sweated laborer is the highest type of intellect in the country. The process by which the sweating is rendered possible is something as follows: Young graduates, fired with enthusiasm for science or with the desire of investigating some question which has occurred to them, take scholarships or poorly paid research-studentships. At first, while they are young, everything goes well with them; but after some years they find that the shoe begins to pinch. Then, unfortunately, it is too late. They have lost the time which they should have used in perfecting themselves for their proper profession, whatever that may be—in which they have already been outpaced by men who formed these sciences in the past or so high-minded as themselves. The opening which they may have taken five years previously is now closed to them; and they are compelled to spend the rest of their life under the paralyzing influences described above. This also is the actual fact; and it must evidently produce a disastrous influence, not only on the men who suffer, but also upon the great studies to which they devote themselves. The most capable graduates are already beginning to perceive the truth and to avoid the toils. The elder men, seeing that investigation leads to nothing, tend to interest themselves only in teaching, compilation of text-books and attendance upon committees. The enthusiasm and concentration which when found together are called genius become impossible; and we look almost in vain for that high devotion to science which is the only quality she rewards with success. And the punishment does not really fall so heavily upon the worker himself—his enthusiasm for science may quite possibly compensate him for such troubles as those

mentioned above. But the punishment falls upon his family; it falls upon the institution which employs him; it falls upon the nation which allows such a thing; and it falls upon science herself. . . . The man of science is now exactly in the position in which writers and inventors found themselves before the copyright and patent acts were passed. He is never the master in his own house; he is the slave to institutions which 'run him' for what he is worth; and is seldom able to spend his time in the exercise of the lofty gift which nature has given him. Still worse, the most capable minds are at the outset turned away from fields in which their efforts are likely to be of the highest value to humanity."

From the foregoing we see that the case of cheap research like cheap lumber, cheap fish, cheap game, cheap fur, cheap grazing, and one may say, most cheap things, is due to the fact that some one has not been paid adequately for his labor, or a "find" has been made of some natural resource. This is not a condition of stable equilibrium; and adjustment should be made toward a fair compensation to man or to society. This is a predatory system which requires correction. As Carver ('17, p. 333) has well said: "If the individual is in part a producer and in part preying upon other people, that part of his work which is productive must be protected and rewarded and that part which is predaceous must be punished. The State need not give itself the slightest concern over the question as to whether he is weak or strong—that would be a silly question anyway. But the question whether his activities are productive or predaceous is a matter of the utmost concern."

SUMMARIZED CONCLUSIONS

1. European forests were originally set aside for game. American forests were cleared away for agriculture and settlement, but their clearing has often been done unwisely, without providing for future forests on lands primarily adapted only to forests.

2. Among the greatest leaders in the forestry movement in America were the sportsmen-naturalists, such as Theodore Roosevelt.

3. Through settlement of the country, and by the destruction of the wilderness haunts of wild life and the animals themselves, we have often wantonly destroyed them, so that the future of this breeding stock has become very seriously menaced.

4. It seems probable that in the future the main haunts of wild life will be found on the non-agricultural or forest lands, the total acreage of which has been estimated to include about 463,000,000 acres of forest. Such an area is capable of providing cover for a vast amount of wild life.

5. In order to have sound economic and social policies applied to our forest lands much scientific study must be made of them, in order to formulate satisfactory land policies. Such studies are a prerequisite for the determination of the character and supervision of the wild life (and the domestic animals) which should be grown in such forests.

6. With increasing population the food problem becomes increasingly important and to a corresponding degree there will be a tendency to increase food production on the non-agricultural or forest lands. The methods of management on such lands differ considerably from those on tilled lands. It is even suggested that with the relative decline in the use of meat from agricultural lands there will be a greater tendency to secure this food from the forests.

7. The food producing capacity of forest lands and waters was reviewed from the standpoint of the production of human animal foods, such as fish, game, and grazing animals, and was shown to be of great economic value.

8. The fish producing capacity of streams was also shown to be of great importance, as in the case of the Illinois River, which in some respects is comparable to the Hudson River. Streams are capable of producing great quantities of fish for food and for recreation.

9. Lakes and ponds were shown to be capable of producing vast quantities of fish, similar to the streams.

10. Foods derived from cold-blooded vertebrates other than fishes were considered briefly, to show that they are of minor but real value and worthy of cultivation.

11. Game was shown to produce a vast amount of food in the form of ducks and other water, swamp, shore and upland game birds. Game mammals also produce food in great quantities, particularly the rabbits and hares, and a few of the large game, such as certain kinds of deer.

12. The domestic animals grazing in our National Forests number 9,500,000 animals, and are today an important source of food, and other valuable animal products. The domesticated reindeer of Alaska promises much from the arctic grazing grounds, and may be supplemented to an important degree by the native caribou and the musk ox.

13. In addition to the food value of game, it is of the greatest value also for social welfare purposes, as for recreation and education, and this aspect has been found to be of increasing interest and importance.

14. Forest lands are to an increasing degree becoming the main

refuge of fur-bearing animals and, like the game, fish and forests, their decline can only be recovered by the application to them of the principles of conservation.

15. The production of furs was given in enough detail to show that it was a very important annual forest crop, capable of great expansion.

16. The fur industry of the world, a billion dollar industry, is centered in New York City, and millions of dollars worth of furs are annually, as a wild crop, harvested largely from our forest lands. Under intelligent management this crop could be greatly increased.

17. At present we have had no national forest policy worked out upon the basis of the centralized and unified control of *all forest crops*, plant and animal. Such policies have in the past been based almost solely upon the timber, which is a slowly growing crop.

18. The animal crops grown in forests may be made to produce an annual revenue of the utmost value in forestry.

19. At present, timber growing on a large scale, has not become widespread because of financial difficulties. The value of annual animal crops from forests is therefore worthy of vastly more serious attention than it has received in the past.

20. Wild life is today paying a large part of the total cost of conservation in New York State, and is capable of doing much more than at present.

21. In the National Forests of the United States and Canada the annual fees from grazing animals today produce 47% and 25%, respectively, of their entire income. When, however, a full charge is made for grazing in our U. S. National Forests the total income from this source alone will be from 4 to 5 million dollars—equal to all other sources of income and making the National Forests practically self-supporting.

22. The recreational value of wild life has an economic as well as a social value. The social cannot be fully expressed in money, but where estimates have been made of its economic value, it is seen to amount to many millions of dollars.

23. Summing up all the annual animal crops which can be harvested from slowly maturing forests, we see that animals possibly contain the "balance of power" necessary to finance the practice of forestry.

24. In order to develop adequately these animal resources, and to fit them into our economic and social system, a new training and new leaders are needed, who will recognize the essential and mutual relations which exist between all forest crops.

25. New constructive policies should be developed and both comprehensive and detailed research must be conducted before this can be done. These policies can not be devised solely by executives, and research must be given greater opportunities and rewards, if forestry is to take its rightful place in relating comprehensive forest utilization to human economic and social welfare.

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THE VALUE OF RESEARCH

When the intellectual history of this time comes to be written, nothing, I think, will stand out more strikingly than the empty gulf in quality between the superb and richly fruitful scientific investigations that are going on, and the general thought of other educated sections of the community. I do not mean that scientific men are, as a whole, a class of supermen, dealing with and thinking about everything in a way altogether better than the common run of humanity, but in their field they think and work with an intensity, an integrity, a breadth, boldness, patience, thoroughness, and faithfulness — excepting only a few artists—which puts their work out of all comparison with any other human activity. . . . In these particular directions the human mind has achieved a new and higher quality of attitude and gesture, a veracity, a self-detachment, and self-abnegating vigor of criticism that tend to spread out and must ultimately spread out to every other human affair.

H. G. WELLS

WILD LIFE AND THE LAND PROBLEM

"All human institutions, associate arrangements, modes of life, have their characteristic imperfections. The natural, perhaps the necessary defect of ours, is their instability, their want of fixedness, not in form only, but even in spirit. The face of physical nature in the United States shares this incessant fluctuation, and the landscape is as variable as the habits of the population. It is time for some abatement in the restless love of change which characterizes us, and makes us almost a nomade rather than a sedentary people. We have now felled forest enough everywhere, in many districts far too much. * * * The establishment of an approximately fixed ratio between the two most broadly characterized distinctions of rural surface—woodland and ploughland—would involve a certain persistence of character in all the branches of industry, all the occupations and habits of life, which depend upon or are immediately connected with either, without implying a rigidity that should exclude flexibility of accommodation to the many changes of external circumstance which human wisdom can neither prevent nor foresee, and would thus help us to become, more emphatically, a well-ordered and stable commonwealth, and, not less conspicuously, a people of progress."

GEORGE P. MARSH.

The Earth as Modified by Human Action, 1874, pp. 396-397.

THE LAND-ECONOMIC SURVEY IN MICHIGAN*

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GENERAL REMARKS

Much has been said and written about what has been called the Michigan Land-Economic Survey, but most of the statements suffer from incompleteness, inaccuracy, exaggeration, lack of proper perspective, and comprehension. Mistaken notions are present and

* We are gradually learning the fundamental economic and social importance of comprehensive land surveys. The basal importance of these in all State and National policies of conservation should become evident. This applies to all uses of the lands, urban, agricultural and forest. That the wild life problems are an integral part of any comprehensive policy has been even slower in gaining general recognition. To stimulate interest in the necessity of adequate economic and social land surveys and in order to orient the wild life problems in this general scheme, I sought in September, 1923, of Mr. R. A. Smith, State Geologist of Michigan (who had charge of the Land-Economic Survey in that State in 1922) a statement of the methods and conditions of that Survey. The present account (President's address given at the March-April meeting of the Michigan Academy of Science, 1923) was later revised in June, 1925, for publication in this *Bulletin*. The Roosevelt Wild Life Station gladly takes this opportunity to present the subject to the citizens of this State and to thank the author for his generous cooperation.—THE DIRECTOR.

there is a general haziness in the minds of most people as to what the Land-Economic Survey is, what it comprehends, and what has been accomplished to date, and how. This paper has for its object the summing up of the facts so far as the writer knows them, so that a clearer conception and a better appreciation of the value and importance of the work may be had.

DEFINITION, SCOPE, AND PURPOSE

The Land-Economic Survey is an inventory of all of the resources of the State, their present condition, how they came to this condition, their possibilities, and how the latter may be developed to best uses of the people and the State. Specifically, it includes surveys of the soils; of forest and plant growth; of fish, game, and wild life; of recreation resources,—i. e., lakes, streams, parks, and resorts; of surface and underground water supplies; of mineral resources; of agricultural development and climatic conditions; of industrial development, and of the economic factors which have influenced or controlled development in the past, and which will affect development in the future.

Stated in another way, it is an inventory of all of the physical resources which contribute or may contribute in an important way to the support and maintenance of community life. The ultimate purpose is to permit the formation of constructive policies looking toward the right and most effective use and development of these various resources in order that failing communities may be rehabilitated and new ones developed and maintained at a level commensurate with the better standards of American life.

NEED FOR A LAND-ECONOMIC SURVEY

Almost everyone who has any knowledge of the real facts agrees that such a survey is not only needed but imperative. True, our information concerning conditions in the State is both very general and fragmentary, but in spite of this it shows conclusively that conditions are not only bad, but are getting worse, and that something ought to, and must be done. If conditions were only half as bad as they now appear an inventory would be justified.

As Mr. P. S. Lovejoy, one of our most outspoken champions of aggressive and intelligent conservation, has said again and again, a third of Michigan is virtually bankrupt. It is unable to provide itself with adequate roads, schools, or churches, or even to maintain

proper local government. Some townships have ceased to function as organized townships and have been joined to more fortunate neighbors. It is a question whether it would not be better for certain counties to be consolidated in the same way. The worst of it is that this third as a whole is getting poorer and worse off each year. The growth and development in the more favored communities are not equal to the decline in people and wealth in the remainder of the area. This part of the State produces less than it consumes. It is a liability instead of an asset. Wrath, so to speak, is being stacked up against a day of judgment and reckoning.

This third of Michigan probably contains about 12,000,000 acres. The area is increasing rapidly each year as fire and pauper farming continue to dissipate the pitiful remnant of Nature's once great bank deposit of timber and soil humus, so beneficently saved up for man's use but so outrageously and ungenerously wasted and destroyed. The most of this great area of semi-waste is in the northern half of the Southern Peninsula, and the remainder is in the Northern Peninsula.

The soils on most of these lands are largely sand and gravel or gradations between the two. These lands were once largely covered with magnificent pine forests, or mixed pine, hemlock, and hardwoods. Though the quality of the timber, especially the white pine, which grew on these lands, was unsurpassed, the soils basically are generally of low to very low agricultural value. It took centuries to produce the forests and the cover of mold or humus. Man and fire in half a century removed most of both and left us a legacy of sandy wastes which at present are, and for some time to come will be, a liability.

For years these pine sand wastes have been the chief stock in trade of the shyster land agent or land "shark." These lands have been sold often at high prices, over and over again, as good farm lands. Unfortunately the victims have been generally working people in cities, ignorant of agricultural values of soils. In many cases these people lost their all and the savings of a lifetime. Only recently has any constructive step* been taken to put an end to this nefarious business. During the past forty years this liability has grown into what is virtually bankruptcy.

* In 1923, a Land Certification Law was passed, under which owners of undeveloped land in Michigan may have their lands surveyed under the direction of the State Department of Agriculture, and their character certificated. The owner must agree to sell the lands only on the facts given in the certified statement. The owner bears the cost of the survey and report.

HISTORY OF SOIL AND ECONOMIC SURVEY

Before a patient can be cured a diagnosis must be made and medicine and treatment prescribed and administered. It may be truly said that a third of Michigan is sick, and a careful diagnosis or inventory of the conditions and symptoms must be made before either medicine or treatment can be intelligently prescribed and administered. This has been recognized for some years but it was not until 1917 that a diagnosis was attempted. Up to this time there have been special or partial surveys and inventories in different fields,—geology, soils, surface geology, agriculture, topography, biology, timber, etc., but each survey was conducted with little relation or regard to the others. Each field was the field of the specialist who had little interest or concern in the fields of other specialists. As a consequence there were gaps and overlaps or duplication of effort and waste of time and money. In fact, most of the individual workers did not recognize that the purpose of their work should have been the diagnosis of the general illness of the State, rather than the determination of its minor local ailments. The diagnosis was necessarily incomplete and inconclusive, and the remedies or treatment could not be prescribed or given.

In the fall of 1916 Mr. R. C. Allen, then State Geologist, presented the situation to Governor W. N. Ferris, who asked Mr. Allen to suggest ways and means of remedying it. Mr. Allen's remedy was the plan of the Soil and Economic Survey which contemplated the same thing as the present Land-Economic Survey. Governor Ferris in his message as retiring Governor recommended to the Legislature the passage of a law carrying an appropriation sufficient to make such a survey or inventory. Governor A. E. Sleeper at first approved the bill creating the Soil and Economic Survey, but later decided that it was a mistake. He signed the bill but on the basis of a war expediency he refused permission for the initiation of the work. No doubt he was amply justified in this stand at that time, but two years later he refused to permit a budget for the Soil and Economic Survey to be included in the appropriation for the Geological Survey.

A bill was introduced into the Legislature of 1921 carrying an appropriation of \$25,000 per year to make the Soil and Economic Survey operative. The bill passed the Senate but unfortunately it came up in the House for final vote on the last day of the session,

when less than 60 members were present. It failed of passage, though 47 votes were cast for it and only 8 against it.

During all of this time much effective agitation and educational work had been carried on by the Michigan Academy of Science and other friends of the Soil and Economic Survey. It attracted the attention of men connected with State Departments and institutions. Mr. John A. Doelle, Director of the Bureau of Agricultural Development, and later Commissioner of Agriculture, was a strong and enthusiastic supporter of the Soil and Economic Survey. It was largely his active interest that brought about a cooperative effort between the various State and Federal departments, institutions, and agencies concerned in different phases of the land problem to try out the idea of the Soil and Economic Survey as a pure experiment to determine its merit and value. The name adopted for this experimental work was the Michigan Land-Economic Survey to distinguish it from the Soil and Economic Survey created under Act 373 of 1917. The idea, however, was the same in both surveys.

GENERAL ORGANIZATION

The cooperating bodies were the State Department of Agriculture, the State Department of Conservation, the University of Michigan, Michigan Agricultural College, the United States Geological Survey, the United States Bureau of Plant Industry, the United States Bureau of Fisheries, and the United States Weather Bureau. Each contributed men or money, or both. The University, the Agricultural College, and the United States Bureau of Plant Industry also contributed laboratory space and assistance.

The bringing together of so many of the important State and Federal departments and institutions for trying out this experiment was one of the most remarkable facts connected with the Land-Economic Survey. This enthusiastic and whole-hearted cooperation was significant of the general recognition of the necessity and importance of the work to the State as a whole.

The Land-Economic Survey was an entirely new thing—a new departure from the stereotyped piecemeal surveys. Nothing like it has ever been attempted by any other State. Since its initiation, however, it has attracted the serious attention of several other states having land problems. Inquiries and requests for literature covering the plan, scope, and purpose of the survey have come from the states of Connecticut, North Carolina, Kentucky, Illinois, Missouri, New York, Texas, and Wisconsin; and from Scotland and England.

Several conferences were held between representatives from all of the different fields and agencies interested or concerned. It was agreed that the general supervisory control should be given to the Bureau of Agricultural Development, the State Department of Agriculture. Direction of the work was assigned to the State Geologist. An advisory committee was appointed consisting of nine members, two from each of the four State departments or institutions, and one from the United States Geological Survey. This committee was concerned chiefly with ways and means for effective cooperation and coordination of effort, of field plans, organization, and work. The Advisory Committee approved of the plans, but the State Geologist had direct charge of carrying them out.

All plans and work were based upon the idea of fullest cooperation and coordination practicable. No plans were to be made or work to be done without considering the overlapping and inter-related interests of the different fields and investigators. Each worker was to assist the other and do his work in such a way as to be of maximum use and value to all concerned. Gaps and duplication of work were to be reduced to a minimum. With no previous history of experience in such a complete and comprehensive survey this was an ideal not realized, of course, but toward which very gratifying progress was made.

The close cooperation and coordination had a much greater value than merely increasing the direct efficiency of the results. Its greatest value was in broadening the vision of the individual workers in the different fields. It impressed upon them that the different fields were not independent and unrelated, but that they were closely related parts of a much larger problem of basic economic importance to the life of the community and State, and that the results obtained in one field were in part or whole of great interest and value to workers in other fields. The specialist gained a better perspective of the inter-relations and relative values of the different phases of the work, and quickly recognized that the solution of the problem of our ten or twelve million acres of idle land was not through separate and unrelated surveys of different resources such as soils and agriculture, timber and forest cover, or minerals, water power, etc., but through a complete survey or inventory of all of the resources, conditions, and factors, which have to do with the development and maintenance of healthy community life. This larger vision was the source of the enthusiasm and spirit of cooperation, which carried the work through to successful completion.

ORGANIZATION

The Land-Economic Survey as conducted included at least 10 different surveys in one. It included soils; forest and forest cover; fish, game, and wild life; plant resources; mineral resources; underground waters; water power and surface water resources; peat deposits; industrial development; climatic conditions and crop and climatic records; and economic conditions and development. Obviously the cost of making these surveys separately would be much greater than under the cooperative and coordinated plan. This reduced administration, travel, and subsistence costs to a minimum, and eliminated much duplication of effort and waste of time.

The following is an outline of the organization of the Land-Economic Survey:

1. Advisory Committee:

Department of Agriculture:

John A. Doelle, Commissioner of Agriculture, and Chairman of the Committee; Ezra Levin, Director of the Bureau of Agricultural Development.

Department of Conservation:

Albert Stoll, Jr., Secretary of Department of Conservation; R. A. Smith, State Geologist, Division of Geological Survey.

University of Michigan:

Prof. L. J. Young, Department of Forestry; Prof. C. O. Sauer, Department of Geology and Geography.

Michigan Agricultural College:

Dr. David Friday, President of Michigan Agricultural College; Prof. George Grantham, Department of Soils.

United States Geological Survey:

Frank Leverett, Geologist.

2. Director — R. A. Smith, State Geologist.
3. Field Manager — Prof. L. J. Young, Dept. of Forestry, Univ. of Michigan.
4. Chief of Forestry Division — Prof. L. J. Young.
5. Chief of Soils Division — L. R. Schoenmann, State Dept. of Agriculture.
6. Surface or Soil Geology — Frank Leverett, Geologist, U. S. Geological Survey.
7. Industrial Development — Dr. A. E. White, Dept. of Chemical Engineering, University of Michigan.

8. Mineral Resources — R. A. Smith, State Geologist; W. I. Robinson, Division of Geological Survey.
9. Underground Water Resources — Helen M. Martin, Division of Geological Survey.
10. Water Power and Surface Water Resources — Prof. C. O. Wisler, Department of Hydraulic Engineering, University of Michigan.
11. Wild Life and Game Resources — Dr. A. G. Ruthven, Museum of Zoology, University of Michigan.
12. Plant Resources — Dr. E. A. Bessey, Dept. of Botany, Michigan Agricultural College; Dr. R. H. Harvey, Dept. of Botany, Western State Normal College; Prof. H. T. Darlington, Dept. of Botany, Michigan Agricultural College.
13. Soil Biology — Dr. Ward Giltner, and Dr. Robert Snyder, Department of Bacteriology, Michigan Agricultural College.
14. Peat Resources — Dr. E. A. White, Dept. of Chemical Engineering, University of Michigan; Dr. Charles Robinson, Experiment Station, Michigan Agricultural college; Ezra Levin, Bureau of Agricultural Development, Dept. of Agriculture.
15. Timber Taxation Committee — P. S. Lovejoy, Ann Arbor, Chairman; John Baird, Director Department of Conservation; O. F. Barnes, Ex-member Board of State Tax Commissioners; Herman Lunden, Lewiston, Lumberman; Albert Stoll, Jr., Secretary Department of Conservation, and Secretary of Committee.
16. Forestry — Marcus Schaaf, State Forester, Dept. of Conservation; Prof. Filibert Roth, Dept. of Forestry, Univ. of Michigan; Prof. A. K. Chittenden, Dept. of Forestry, Michigan Agricultural College; Edw. Kingsford, Iron Mountain; Albert Stoll, Jr., Secretary Department of Conservation.
17. Parks, Resorts, and Recreation — Thos. F. Marston, Conservation Committee, Secretary Northeastern Michigan Development Bureau, Bay City, Chairman of Committee; Earl Moore, Secretary Western Michigan Development Bureau, Grand Rapids; G. E. Bishop, Marquette, Secretary Upper Peninsula Development Bureau; Hugh T. Gray, Secretary Michigan Tourists' Association, Grand Rapids.
18. Climate — Dewey A. Seeley, U. S. Weather Bureau, East Lansing.

19. Crop and Climatic Record—Ezra Levin, Director Bureau of Agricultural Development; Professor George Grantham, Michigan Agricultural College.
20. Reports and Publications—Helen M. Martin, Editor of Geological Survey Division, Department of Conservation.

The organization was complex and ponderous. It was weak not only because of its complex character, but because it rested merely upon voluntary cooperation. Surprising as it may seem, it functioned well and showed little sign of disintegration until some time after the field work was completed in October. Its success was due largely to the broad-minded attitude of the men, and their enthusiasm for, and keen appreciation of, the value and importance of the work. Personal or departmental jealousy and ambition were practically absent.

The United States Bureau of Soils and the Department of Soils of the Michigan Agricultural College did not cooperate. Under a previous cooperative agreement they were conducting a straight soil survey. As the Land-Economic Survey was an experiment it was thought best to conduct it independently from the regular soil survey.

Some of the divisions were organized so late in the session that competent men were not available. This was especially true in the biological work. As a result the survey as conducted was not complete for all of the fields. Some of the investigatory committees failed to act for one reason or another. The timber taxation committee did most excellent work and their results are embodied in a new timber land taxation bill* before the present Legislature. This is a most important measure and is the first feasible plan for bringing about a reforestation of our low-grade idle lands.

SELECTION OF UNIT OF SURVEY

It was agreed unanimously by the Advisory Committee that the Land-Economic Survey was to be made with the county as a unit. The county was considered the most logical unit and moreover this was in harmony with the provisions of Act 373 of 1917.

The selection of a specific county to initiate the work was more difficult. Upon the basis that the county chosen should contain the greatest range and variety of soil and economic conditions the choice fell upon Charlevoix County.

* This failed of passage in 1923, but a modified bill was passed in 1925.

The field men were grouped together in parties working from movable base camps. The parties were composed of three different groups of workers—(a) soils men; (b) foresters; and (c) special or unattached workers. The parties were built around the soils men and the foresters. The unattached workers used the field camps chiefly as convenient and cheap bases from which to work.

There were two field parties, each comprising from 8 to 12 soils men and foresters, one or more special workers, and a camp cook. The number of soils men and foresters in each party was the same. The soils men and foresters worked in pairs, a soils man and a forester in each pair. Each was responsible for the work for his own particular field, and such other work related to other fields as might, in the equitable division of labor, be assigned to him. To the forester, however, was given the responsibility of line or traverse control. This was chiefly because of the nature of the work, foresters generally receiving more definite instruction and practice in the technique of land surveying.

The special investigators such as the botanists or zoologists worked independently in pairs, or attached themselves to the soil-forestry pair, as the nature of the work and conditions warranted. The independent investigator is generally confronted with the necessity of burdening himself with camping equipment, or of boarding at hotels relatively distant from his work. Both are consumers of valuable time and energy, and the latter is also expensive. The heavy field camps increased the effective working time and freed the workers from the usual inconveniences and hardships incidental to field parties having only light camping equipment.

The mapping of the field was done by sections on sheets eight inches to the mile. This scale afterwards was found to be unnecessarily large. A scale of four inches to the mile would be amply large for the kind of survey contemplated. Two sets of field maps were made. One set made by the soils men showed the various classes of soils and their distribution; and the other, made by the foresters, showed surface conditions. From these sheets three sets of township maps were made—one showing topography or surface features, and the third showing forest cover and culture. The latter is known as the condition map, the idea for which was borrowed from the Canadian surveys. The county map was made on a scale of two inches to the mile.

In the field all mappable data and information are entered upon the field sheet. This includes in particular the different types of soil and their distribution, the topography and surface features, the



forest and forest cover, by classes and varieties, agricultural development, and general culture. The remainder of the data and information is entered upon a tally sheet. This data and information covers a wide range and includes all the fields or subjects of investigation, as may be seen from the accompanying tally sheet.

The work of obtaining most of the data and information called for by the tally sheet was divided between the soils workers and foresters. It was found difficult to make a satisfactory and workable division of the labor between the two groups. The tally sheet was later revised and divided into two separate parts—one for the foresters and one for the soils men. It was also found that the foresters did their work more rapidly, and in 1924 the plan* of independent work is to be tried.

The question may be asked—why require soils men and the foresters to obtain so much data and information more or less foreign to their fields of work? Why not have the special workers get the data and information for their respective fields? There are several reasons, chief of which is that it would be a waste of time and money to require so many different workers to go over the same ground to obtain data and information which could be readily obtained by almost any one having some scientific training. The soils men and foresters must cover all the ground; therefore, with relatively little additional effort and time they can collect much of the data and information desired by other investigators. The special investigators are therefore enabled to devote their time to the more difficult and important phases of their work. Actual experience demonstrated, however, that some of the data and information on the tally sheet is better and more efficiently obtained by the special workers than by the soils men and foresters. In short, this plan had for its object the obtaining of a maximum of data with a minimum of effort through cooperative and coordinated machinery. These details of field technique are illustrative of the many minor problems which confronted those having the responsibility for carrying out the work efficiently and effectively. The field technique was as new and complex as the survey itself.

THE INITIATION OF THE WORK

Field organization was delayed until after April 1, 1922. The season was so late that most college and university men had already planned their summer's work. It was difficult to find enough men with proper training and experience for the work. It was not until

* This plan proved more efficient and has been adopted for future field work.

after the Fourth of July that the parties were organized and in the field. The survey of Charlevoix County, however, was practically completed by October 1. The detailed soil, topographic and condition maps, also some of the smaller sketch maps and reports, were completed by April 1, 1923.

RESULTS

The maps and the tally sheet show that a large amount of detailed data and information on the various resources and conditions in Charlevoix County was obtained. This data and information covers the subject of soils; climate; forest and forest cover; fish, game, and wild life; water power and drainage; streams and lakes; underground water supplies; geology and mineral resources—limestone and shale, sand and gravel, peat and marl deposits; industries—agriculture, horticulture, dairying and lumbering; resorts and recreation possibilities; transportation and marketing facilities; land ownership values and uses; economic conditions and factors. This forms a great mass of knowledge for more detailed economic studies of the county and territory adjacent. The summary of the land data for Charlevoix County is given on the accompanying table. This is fairly representative of the character and amount of information collected for each of the fields of investigation.

Such inventories give the basic facts upon which generalizations may be made and constructive land policies formulated. Without such facts intelligent utilization and development of the resources are impossible.

The soil and condition maps, supplemented by the information on the tally sheet, make it possible to determine definitely the best and most profitable uses of the land and its resources. For example, the maps and information covering Charlevoix County show that the western part of the county is adapted to general farming and fruit raising; that the central is adapted to dairying and fruits; but that most of the eastern part should be held as a part of the forest reserve. Specifically the Land-Economic Survey delimits the areas of definitely agricultural and non-agricultural lands, and indicates also those areas of marginal lands of intermediate grade or value, which, depending upon economic conditions, may be used either for agriculture or for growing forests. The Department of Agriculture and the Michigan Agricultural College have the bases upon which to plan constructive work for developing specific lines or phases of agriculture. The Department of Conservation has its field of operation clearly delimited. It can intelligently plan its forest preserves, its program of planting, forest fire protection and fish and

game conservation and propagation. Chambers of Commerce will have the information for developing resources and industries for local needs. With intelligent development of the resources, and the industries growing out of these, together with an aggressive and comprehensive plan for forest fire protection and reforestation, and development and conservation of recreation resources on the part of the State, it is certain that the bankrupt third of the State can be made solvent and self-supporting. Healthy communities will rise on the areas of the better grades of lands and vast forests of young timber will be growing on our sandy wastes. Both will be to the mutual advantage of each other, and to the well being of the State as a whole. The consummation of this ideal is not only a duty we owe to our posterity but a penance for our wanton waste and destruction of the past.

PRESENT STATUS OF LAND-ECONOMIC SURVEY

The Legislature of 1923 failed to make provision for continuing the Land-Economic Survey. Recognizing the importance and value of this Survey Mr. John Baird, Director of the Department of Conservation, provided the necessary funds from the Department's appropriations. Mr. P. S. Lovejoy was placed in charge. The work was carried on along much the same lines as in the previous season, but the direction was entirely under the Department of Conservation. This avoided the complex and unwieldy cooperative organization. Cooperation was the key-note, however, as before, in all phases of the work. The cooperating agencies were the United States Geological Survey, the Soils Department of the Michigan Agricultural College, the U. S. Bureau of Soils, the U. S. Forest Service, U. S. Bureau of Plant Industry, and the U. S. Bureau of Fisheries.

With a year's experience and training the field organization was able to make much more rapid progress, with the result that two counties, Ogemaw and Antrim, were completely mapped. The costs were nearly cut in half and it is expected that with greater refinement in field technique and more experience of the field men, that costs will again be reduced in 1924.*

* The costs were reduced to less than 3 cents per acre for the field work in 1924.

Results of the work in 1923 have even more conclusively demonstrated the need and value of the Land-Economic Survey. By the end of 1924 it is expected that at least five counties will have been completely surveyed.* Enough of the State will have been covered to permit the initiation of constructive and intelligent policies of conservation and land utilization.

* The five counties were completed, and the maps and reports for four counties were ready for the printer by June, 1925.

The Legislature of 1925 made a specific appropriation for the Land-Economic Survey, which became a separate division of work of the Department of Conservation. Mr. H. J. Andrews, formerly of the Department of Forestry, Iowa State College, was in charge until 1926, when Mr. L. R. Schoenmann, Chief of Soils, was head of the Land Economic Survey Division.

CURRENT STATION NOTES

By DR. CHARLES C. ADAMS

RESIGNATION OF DIRECTOR ADAMS

As this number of the *Bulletin* goes to press, the Director of the Roosevelt Wild Life Station and Editor of this *Bulletin*, resigns to become Director, on May 1, 1926, of the New York State Museum of the University of the State of New York, at Albany, New York. It is therefore opportune to summarize the work of the Roosevelt Station since its inception, and to indicate its relation to the educational and research work of the College and of the State. The following article, reprinted by permission of Dr. John B. Howe, Editor of the *Syracuse Herald*, was prepared at his request, and with adaptations was published in the *Herald* on April 11, 1926.

WILD LIFE IN RELATION TO FORESTRY

That the wild life of the forests should be considered a part of the practice of modern forestry seems strange to many persons who are accustomed to think of forestry as concerned solely with trees. These persons do not think of forestry as a method of using the non-agricultural lands to the best possible human advantage. This, however, is the modern conception of forestry. We have not yet become thoroughly accustomed to this idea as a far-sighted method of using land, and yet this is one of the most important motives for the practice of forestry. Land areas which are therefore not suitable for agricultural or other special uses should, instead of allowing them to become absolutely or relatively unproductive and a drag on the community, be put under some system of forestry management, so that they will grow forests which will not only produce timber, but also fish, game and fur-bearing animals, as well as for other uses, including recreation. We must realize, of course, that angling and hunting are largely recreation for the vast majority of people.

The needs of modern society are so varied and changeable that there is much to be said for the diversified use of all lands, that is, to make every piece of land produce as great a variety of crops, plant and animal, as can be justified under local conditions. The degree of emphasis should depend of course on many influences, both economic and social. In some cases timber production should re-

ceive primary emphasis, in others game, in still others camping and other forms of recreation, but all uses should be intelligently correlated into a well-balanced constructive system. Wild life forestry should be made to fit into such a comprehensive plan. This does not mean undue emphasis, nor its neglect, but its full legitimate share in such a program.

With the inauguration of Dr. Hugh P. Baker as Dean of the New York State College of Forestry in 1912, there soon developed at the College this comprehensive forestry policy, which has been the unique feature of its aim, and has made it a leading and distinctive institution in this field. The Trustees, Dean Franklin Moon, the College faculty, and the Roosevelt Station staff, have continued this broad policy.

With the foregoing interpretation of forestry, the wild life problems of the forest and their included waters involve a program for training of young men in such matters, and of studying the conditions of forest animals, and formulating such information as will enable the public to improve them. By such methods animals which are valuable for angling, fishing, hunting and trapping, or for educational purposes, should be increased in every possible way, and satisfactory methods should be devised for their proper utilization from an economic standpoint, and as well from the standpoint of social welfare—for this includes the recreational, educational and other phases not evaluated primarily as economic, and yet of the utmost importance.

In order to get down to the practical problems, the College staff of forest zoologists, and their collaborators, began a survey of Oneida Lake. Here is a large lake, near the College, which can be used as a training school for our forestry students in getting the fundamentals of the conservation of fish in public waters. This lake is shallow and is one of the finest bodies of water in the State for the practice of fish culture. The State has a fish hatchery at Constantia on this lake, but has not been able to make any elaborate studies of the fisheries.

Our staff found about 60 kinds of fish there. A whole series of questions came up about this lake. Was it producing all the fish that it should? What amount of fish food was present? The fish food-producing capacity of the lake was therefore a very practical problem of the greatest importance. Many fish were found injured or diseased. So studies were made to learn all that was possible about the fish and fishing conditions of the lake, and after several years this work resulted in a series of publications on the amount and kind of fish food in the lake, and preliminary studies of the

diseases of the fish were made. Many of the results are as yet unpublished for lack of funds. Without question the shores of this lake are settling up so rapidly with cottages, that in the near future it will probably become a lake devoted mainly to angling, and commercial fishing will decline considerably. The method of handling or managing the fisheries will thus need to change, corresponding with public needs. But to make a proper transition it will continue to require extensive fish cultural research. The Oneida Lake studies are representative of the methods and aims of wild life forestry, and are of particular value to the people of Syracuse because of their great interest in this lake.

But this work of the College has not by any means been limited to the vicinity of Syracuse. In December, 1916, a plan was presented to the late Colonel Theodore Roosevelt for a comprehensive program on wild life. This aroused his keen interest and hearty support because he knew the urgent need of such a fact-finding organization, whose sole duties should be to increase our knowledge of wild life. These plans were well under way when the United States entered the war, so the plan was set aside for its duration. Soon after the Armistice, however, Colonel Roosevelt died, and the Trustees of the College presented a bill to the Legislature to establish the "Roosevelt Wild Life Forest Experiment Station," as a part of the College of Forestry. The Roosevelt family gave permission for the use of the name, and the law was passed in May, 1919. The Honorary Advisory Council included such personal friends of Roosevelt as Viscount Grey of Fallodon, Viscount Bryce and Sir Harry H. Johnston of England, and Mrs. Douglas Robinson, Honorable Theodore Roosevelt, Mr. Kermit Roosevelt, Dr. George Bird Grinnell, Governor Gifford Pinchot, Mr. Chauncey J. Hamlin, Dr. George Shiras, 3rd, Dr. Frank M. Chapman, and Dean Henry S. Graves,—a very distinguished and representative group of persons.

At about this time Mr. George W. Perkins, then President of the Commissioners of the Palisades Interstate Park on the Hudson, and an old friend of Colonel Roosevelt, became interested in having a fish and bird survey of the Park. With the cooperation of the Park Commissioners, the United States Bureau of Fisheries, and the newly established Roosevelt Station, this work was carried on for two years. The work was expanded at the urgent request of the Commissioners, to aid them in some of their administrative difficulties, to include studies of the control of leeches—which bothered bathers in the lakes, as did the "water-bloom",—and finally also in-

cluded the control of the mosquitoes by fishes. All of these studies resulted in publications prepared by capable specialists. As a by-product of these a bulletin was prepared on recreational forestry, for which there has been one of the greatest demands made for any publication by the College.

The influence of these studies in the Palisades Park did not stop there, for the experience gained, under the leadership of Mr. Chauncey J. Hamlin of Buffalo, led directly to the establishment of the Allegany State Park. Working in cooperation with the Commissioners of this Park, surveys of the birds and trout were then made by the Roosevelt Station. The report on the birds has been published and that on the trout is now completed and awaits publication. This latter is an intensive study of the trout in 10 miles of stream and has produced results of great interest and importance. The establishment and organization of this Park, coming when it did enabled its Commissioners to secure, through the help of the Roosevelt Station, very valuable supplies of the United States Army equipment, valued at over a half million dollars, and now with the new State bond issue the Park will have two millions for development and the purchase of land.

Eight sportsmen's organizations in Erie County, working in cooperation with the Buffalo Society of Natural Sciences and the Roosevelt Station, conducted a fish survey of that region and in a very concrete fashion taught these sportsmen a valuable lesson on the value of stream surveys in fish culture.

In the Adirondacks the Roosevelt Station has conducted, in cooperation with the State Conservation Commission, a study of the trout and other fish of Cranberry Lake, and the report on these investigations is now completed and awaits publication. Studies have also been made of the summer birds of the same region and a report has been published on the relation of these birds to the forest.

Other Adirondack studies have included the beaver. These studies were started by gifts of funds by the Trustees, led by Honorable Louis Marshall. Later the investigations were extended and showed very clearly that the public has often been mistaken and misinformed on the influence of these animals and of their economic importance. Another study of a fur-bearing animal was devoted to the muskrat, the most important fur-bearing animal in the State. Another contribution to the fur industry was a suggestion from the Roosevelt Station—at an opportune moment—that resulted in the organization of the National Association of the Fur Industry, whose headquarters are in New York City, the center of this industry for the

world. This is an industry which transacts about a billion dollars worth of business each year.

Although the Roosevelt Station is a State agency, the College Charter provides that when gifts of funds or expert services are provided, it is permitted to conduct research outside of the State, when it is to the advantage of the College to do so; through this provision and through the cooperation of friends of the Station, research on wild life has been conducted in the Yellowstone National Park, on fish, big game, and beaver; and in Estes Park, Colorado, also on the beaver. Valuable studies on Yellowstone birds have also been presented to the Station and published. The various publications on the results of these researches have attracted widespread attention and have received very hearty approval from competent judges.

The preceding sketch of the wild life studies, all made in relation to forests and parks, shows that a considerable variety of problems have been studied. Many persons have cooperated, including numerous State and Federal officials, collaborating naturalists, sportsmen's organizations, and those who have contributed thousands of dollars in gifts to further a kind of work in which they have great faith. There is good reason for believing that work of this character, devoted to practical wild life problems, is not only in keeping with Rooseveltian conservation ideals, but as well is a type of public service which appeals to a large public, and supplies to some degree a kind of leadership which is much needed.

NEW RESEARCH PROBLEMS AND PUBLICATIONS

All serial publications of the Roosevelt Wild Life Station to date are listed on the inside covers of this *Bulletin*. Those publications now in press include the following:

Relation of Birds to Woodlots in New York State, by W. L. McAtee; Roosevelt Wild Life Bulletin Vol. 4, No. 1.

The Predatory and Fur-bearing Animals of Yellowstone National Park, by M. P. Skinner; Roosevelt Wild Life Bulletin Vol. 4, No. 2.

A Study of the Beaver in the Yancey Region of Yellowstone National Park, by E. R. Warren; Roosevelt Wild Life Annals, Vol. 1, Nos. 1-2.

Notes on the Beaver Colonies in the Longs Peak Region of Estes Park, Colorado, by E. R. Warren; Roosevelt Wild Life Annals, Vol. 1, Nos. 1-2.

In addition to the above, the following thirteen research problems have been completed as to field work (with the exception of the last two) and the reports are now being prepared for publication:

A Trout Survey of the Allegany State Park, by W. C. Kendall and W. A. Dence.

A Preliminary Survey of the Fishes of the Allegany State Park in 1921, by T. L. Hankinson.

An Account of the Birds of the Palisades Interstate Park, by P. M. Silloway.

An Investigation of the Trout of Cranberry Lake, New York, by W. C. Kendall and W. A. Dence.

Notes on the Suckers of Cranberry Lake, New York, by W. C. Kendall and W. A. Dence.

Investigations of the Life History of the Ruffed Grouse in Eastern New York, by A. O. Gross and C. G. Weymouth.

Present Status of Beaver in the Adirondacks, by C. E. Johnson.

The Ecology of Trout Streams in Yellowstone National Park, by R. A. Muttkowski.

The Food of Trout Stream Insects in Yellowstone National Park, by R. A. Muttkowski and G. M. Smith.

The Ecology and Economics of Oncida Lake Fish, by Chas. C. Adams and T. L. Hankinson.

A Preliminary Report on the Adirondack Deer, by B. A. Scudder.

The Summer Birds of the Adirondack Mountains, by A. A. Saunders. (Field studies under way.)

The Relation of the Red Squirrel to the Forest, by R. T. Hatt. (Field studies under way; made in cooperation with the Harvard Forest, Harvard University.)

ACKNOWLEDGMENTS

In concluding my official relations with the New York State College of Forestry, as Director of the Roosevelt Wild Life Station, I wish first of all to express my deep gratitude for the keen interest of the late Colonel Theodore Roosevelt in the first suggestions I made to him about the need for an organization devoted primarily to the study of forest wild life. Without his active interest and support the present Station would not have been established. I desire also to express to the following persons my grateful appreciation for their generous cooperation: to Dr. Hugh P. Baker, Dean of the College during the establishment of the Station, for his enthusiastic support, as without this aid the Station could not have been successfully launched; to the Trustees and the present Dean, Franklin F. Moon, for the support which has continued the work of the Station; to the Honorary Advisory Council for their moral and other support, which has been of the greatest value, particularly during the first years; to

the past and present members of the Roosevelt Station staff, men devoted to the cause, and the other friends of the Station, working with whom has been the pleasantest feature of my connection with the Station; to the various scientific men who in temporary employment or as collaborators have cooperated most efficiently,—in which relations the Station has been particularly fortunate; to the many friends who have generously assisted with gifts of funds and other kinds of active cooperation; and finally to the Assistant Director, Alvin G. Whitney, and the Assistant Ichthyologist, Wilford A. Dence, who have throughout shared the responsibilities in this undertaking.

THE ROOSEVELT WILD LIFE MEMORIAL

As a State Memorial

The State of New York is the trustee of this wild life Memorial to Theodore Roosevelt. The New York State College of Forestry at Syracuse is a State institution supported solely by State funds, and the Roosevelt Wild Life Forest Experiment Station is a part of this institution. The Trustees are State officials. A legislative mandate instructed them as follows:

"To establish and conduct an experimental station to be known as 'Roosevelt Wild Life Forest Experiment Station,' in which there shall be maintained records of the results of the experiments and investigations made and research work accomplished; also a library of works, publications, papers and data having to do with wild life, together with means for practical illustration and demonstration, which library shall, at all reasonable hours, be open to the public." [Laws of New York, chapter 536. Became a law May 10, 1919.]

As a General Memorial

While this Memorial Station was founded by New York State, its functions are not limited solely to the State. The Trustees are further authorized to cooperate with other agencies, so that the work is by no means limited to the boundaries of the State or by State funds. Provision for this has been made by the law as follows:

"To enter into any contract necessary or appropriate for carrying out any of the purposes or objects of the College, including such as shall involve cooperation with any person, corporation or association or any department of the government of the State of New York or of the United States in laboratory, experimental, investigative or research work, and the acceptance from such person, corporation, association, or department of the State or Federal government of gifts or contributions of money, expert service, labor, materials, apparatus, appliances or other property in connection therewith." [Laws of New York, chapter 42. Became a law March 7, 1918.]

By these laws the Empire State has made provision to conduct forest wild life research upon a comprehensive basis, and on a plan as broad as that approved by Theodore Roosevelt himself.

Form of Bequest to the Roosevelt Wild Life Memorial

I hereby give and bequeath to the Roosevelt Wild Life Forest Experiment Station of The New York State College of Forestry at Syracuse, for wild life research, library, and for publication, the sum of, or the following books, lands, etc.

ROOSEVELT WILD LIFE BULLETIN, Vol. 2, No. 2. February, 1924.

1. Ecology of the Plankton Algae in the Palisades Interstate Park,
Including the Relation of Control Methods to Fish Culture.....
Dr. Gilbert M. Smith.

ROOSEVELT WILD LIFE BULLETIN, Vol. 2, No. 3. March, 1924.

1. The Status of Fish Culture in Our Inland Public Waters, and the
Role of Investigation in the Maintenance of Fish Resources.....
Dr. William C. Kendall.
2. Current Station Notes.....The Director and Editor.

ROOSEVELT WILD LIFE BULLETIN, Vol. 2, No. 4. February, 1925.

1. The Relation of Wild Life to the Public in National and State
Parks.....Dr. Charles C. Adams.
2. The Big Game Animals of Yellowstone National Park..Edmund Heller.
3. The Food of Trout in Yellowstone National Park.....
Dr. Richard A. Muttkowski.
4. Current Station Notes.....The Director and Editor.

ROOSEVELT WILD LIFE BULLETIN, Vol. 3, No. 1. February, 1925.

1. The Birds of the Yellowstone National Park.....Milton P. Skinner.
2. Current Station Notes.....The Director and Editor.

ROOSEVELT WILD LIFE BULLETIN, Vol. 3, No. 2. March, 1925.

1. The Muskrat in New York: Its Natural History and Economics.....
Dr. Charles E. Johnson.
2. Current Station Notes.....The Director and Editor.

ROOSEVELT WILD LIFE BULLETIN, Vol. 3, No. 3. September, 1926.

1. The Summer Birds of Central New York Marshes.Aretas A. Saunders.
2. Additional Notes on the Summer Birds of Allegany State Park.....
Aretas A. Saunders.
3. Current Station Notes.....Dr. Charles C. Adams.

ROOSEVELT WILD LIFE BULLETIN, Vol. 3, No. 4. October, 1926.

1. The Economic and Social Importance of Animals in Forestry, with
Special Reference to Wild Life.....Dr. Charles C. Adams.
2. The Land-economic Survey in Michigan.....R. A. Smith.
3. Current Station Notes.....Dr. Charles C. Adams.

